

PERSONAL TRAITS AND EXPERIENTIAL CHARACTERISTICS OF
DEVELOPMENTAL MATHEMATICS FACULTY: IMPACT ON
STUDENT SUCCESS

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PERSONAL TRAITS AND EXPERIENTIAL CHARACTERISTICS OF
DEVELOPMENTAL MATHEMATICS FACULTY: IMPACT ON
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Abstract

Michael Preuss. PERSONAL TRAITS AND EXPERIENTIAL CHARACTERISTICS OF DEVELOPMENTAL MATHEMATICS FACULTY: IMPACT ON STUDENT SUCCESS. (Under the direction of Dr. Margaret E. Ackerman) School of Education, March, 2008. This ex post facto study of the relationship of selected personal traits and experiential characteristics of developmental mathematics faculty with student success rates was conducted at a rural, North Carolina community college. The data gathered was from all classroom based sections of three levels of developmental mathematics taught between fall of 2003 and spring of 2007 and from faculty personnel records. Chi-square and p-value calculations were completed for 15 hypotheses regarding the impact of the traits and characteristics of the 24 developmental mathematics faculty on student success rates. Many of the comparisons made in the study are the first of their kind in developmental mathematics. Results indicate associations of both the personal traits and experiential characteristics of faculty with student success in developmental mathematics. These associations have implications for community colleges in respect to departmental or instructional planning, faculty professional development, faculty recruitment, institutional planning and educational research as well as implications for undergraduate and graduate instruction in mathematics and Education, for the governance of community college and university systems and for the actions of individual faculty and students within these institutions. Suggestions for further research are also included.

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CHAPTER 1 – BACKGROUND AND SIGNIFICANCE OF THE PROBLEM

This dissertation addresses a concern common to all regions of the United States, all institutions of higher education, and to the future of the American work force, student success rates in developmental mathematics. In this chapter, key terms used throughout the document are defined, the background of the study is discussed, a statement of the problem is provided, the significance of the problem is described, an overview of the methodology of the study is given, and the organizational scheme of the document is introduced.

Definitions of Key Terms

In the following chapters, the phrases developmental education, developmental mathematics, faculty member, passing rate, and success rate as well as the terms remedial, remediation, failure and withdrawal are employed. Each has a specific meaning within this dissertation.

Developmental education is an umbrella phrase (Boylan & Bonham, 2007), a perspective of an area of higher education practice and a specific phrase. As an umbrella phrase, it refers to an area of professional practice in higher education. This area of professional practice is an aspect of the learning assistance provided in higher education. In developmental education, the assistance covers a spectrum of services from pre-college level instruction (Boylan, Bonham & White, 1999) to academic enrichment and support programs (Arendale, 2002b) which can include a focus on “academic preparedness, diagnostic assessment and placement, development of general and discipline-specific learning strategies, and affective barriers to learning” (Colorado Adult

Education Professional Association, 2007, para. 7) as well as social constructs (Casazza, 1999; Higbee, 1996). In the ideal case, these efforts occur at all levels of higher education (Casazza, 1999). The areas of need and academic disciplines within which they are addressed are often defined by local institutions or state systems (Colorado Adult Education Professional Association, 2007; North Carolina Community College System [NCCCS], 2007). Thus, developmental education is an area of practice in higher education based upon the value of human potential which seeks to facilitate increased learner self-regulation in specific and locally identified knowledge, skill and attributes by utilizing theories from a variety of academic disciplines when providing learning assistance and instruction.

When used to describe a perspective of professional practice, developmental education is “development of the whole student, not just the development of intellectual competence” (Higbee, 1996, p. 4). This is undertaken with the goals of “excellence in teaching...content areas...[and] educating well-rounded individuals who will emerge from...colleges and universities prepared for the years to come” (Higbee, 1996, p. 4). Thus, learning assistance educators with a developmental perspective seek to capitalize on contemporary understandings of individual growth and learning theory and address cognitive, social and affective development (McCabe & Day, 1998, p. 20). This understanding of the phrase developmental education will not be employed in this study.

A specific meaning for the phrase developmental education will be employed when referring to the study site and the courses included in the study. The specific meaning has been noted above at the low end of the spectrum of learning assistance applications in higher education, pre-college level instruction intended to prepare the

student for college level credit courses. The phrase will be applied in this document within the academic discipline mathematics. Developmental mathematics courses taught at colleges often do not count toward degree, program or certificate completion but are designed to prepare students for college credit level mathematics courses. Completion of these courses at the research setting does not result in academic credit transferable to other institutions although it results in institutional credit.

The terms remediation and remedial are often used in relation to developmental education settings. They occur in phrases like remedial courses and remedial course work and references to student remediation. The definition of remedial or remediation employed throughout this document is a “noncredit course teaching what is generally considered precollege content” (Boylan & Bonham, 2007, p. 2). The reader will note that this definition overlaps that of developmental education employed in the study. The phrase developmental education and the terms remedial and remediation will be treated as synonyms throughout this document as the level of instruction being considered is pre-college level mathematics although the terms remedial and remediation will be employed sparingly.

The phrase faculty member and terms instructor and teacher are used interchangeably below. They designate the college employee with either part time or full time employment status tasked with instruction of students.

In this dissertation, the term student designates an individual who has registered for, paid tuition for, and attends a course or group of courses at the college which served as the research site. This term includes all individuals who took classes regardless of the number of credit hours for which they were registered. This term does not include

persons who registered for and paid for classes but do not attend them or persons who dropped classes at the college during the college specified drop/add period at the beginning of the semester.

Passing rate and success rate are interchangeable phrases in the text below. They designate the percentage of active students who complete a course with a cumulative course grade of A, B, or C. Achieving these grades required a cumulative average of 70% or higher in a course at the research site.

Failure is employed in this document to describe a student or group of students who achieved a grade of F. At the research site this requires a cumulative average of grades equal to or below 60%.

A withdrawal designates a student who persisted in the class past the college defined drop/add period and then chooses to stop attending class or asks to be allowed to discontinue active enrollment in the class. Students who stop attending class reached a maximum number of permitted absences and are automatically withdrawn at the research site. Students might also request a withdrawal from their instructor. This grade designation was granted on a case by case basis but without discrimination. While students seeking to withdraw might be encouraged by their instructors to persist in class, their requests for withdrawals were not denied.

Background of the Study

The background of the study includes societal, philosophical, professional, and research considerations. These topics will be addressed in the order listed above.

Societal Background

Life skills and work force preparation are the societal background of student success rates in developmental mathematics. The American society and economy are dynamic and changing. Current changes include an increase in demands for technical skills among the populace. This demand occurs in general life skills and employment skills. It is commonly believed that a foundational element for the development of these skills is competence in mathematics. This simple connection which is widely accepted and advocated, mathematic competence supporting the development of computational, analytical, and technical life and employment skills (Darken, 1995), is the societal background of the study. That there is a need for mathematical and technological competence in American society is easily illustrated by considering ubiquitous technologies, their integration in American employment and the inclusion of this characteristic in government, business and educational planning.

There are a large number and variety of technologies integrated into everyday life in the United States. Many of these technologies are microprocessor based and were invented in the later half of the 20th century. Examples of microprocessor based technology invented in the 20th century which are ubiquitous in the 21st century include the microwave oven (National Association of Manufacturers [NAM], 2005, p. 2), the handheld calculator (NAM, 2005, p.2), the personal computer (NAM, 2005, p. 2), digital videodisks [DVD] and DVD players (Carr et al., 2006a), duplex mobile telephones (Carr et al., 2006d), personal digital assistants (Carr et al., 2006c), and global positioning devices (Carr et al., 2006b). While considered simple and common, each of these devices is technological and requires the use of logic, mathematics or both. Any reader familiar

with American society can attest that these devices and many others like them have become integrated into American life and work.

The American work force may confront any of the above technologies in their place of employment as well as many other technologies specific to their area of responsibility which are also microprocessor based and require the use of logic and mathematics (Business-Higher Education Forum, 2005; NAM, 2005; National Science Board Committee on Education and Human Resources Task Force on National Workforce Policies for Science and Engineering, 2003; United States Government Accountability Office, 2005). This is a product and exemplar of a shift toward mathematics and technology related skill sets in American employment (NAM, 2005, p. 3). The literature addressing job skills in such diverse fields as veterinary medicine (Snyder, 2004), retail and wholesale employment (Woodburn, 2004), manufacturing (Cummings, 2006; NAM, 2005), engineering (Andres, 2006; Smith, 2006), farming (Cabrini, Stark, Onal, Irwin, Good & Martines-Filho, 2004; Ungar, Seligan, & Noy-Meir, 2004) and information technology (Business-Higher Education Forum [BHEF], 2005; NAM, 2005; United States Government Accountability Office, 2005) illustrates the shift toward mathematic and technological skill. As the diversity and levels of professional standing in these fields indicates, the requirement for mathematic and technology skill sets extends to all levels of employment, entry level to management and administration.

A populace with math skill is a critical concern and assumption in the economic predictions for the United States (BHEF, 2005; Hector, 1993; National Science Board Committee on Education and Human Resources Task Force on National Workforce Policies for Science and Engineering, 2003; United States Government Accountability

Office, 2005). Between 1990 and 2000, the US economy was predicted to add 21 million jobs most of which would require a minimum of some post secondary education and mathematics skills (Hector, 1993). Beyond this, opportunities for employment in the fields of mathematics and technology are increasing. The need for skilled workers in the areas of science, technology, engineering, and mathematics [STEM] is expanding. The U.S. Department of Labor estimated that jobs related to STEM would increase by 51% between 1998 and 2008, four times the projected overall job growth rate (BHEF, 2005, p. 7). The general nature of and expansion in need for advanced practitioners of STEM led the BHEF to state that mathematic skill is a foundation of the American economy and is required of all workers (BHEF, 2005, p. 5). Darken made similar statements a decade earlier (1995b). The view that mathematic skill is foundational to the American economy is a view shared by many leaders in government, business and education.

The belief that mathematic competence is a baseline for life skills and employment influences political, economic, and educational decision making at many levels. It accounts for presidential initiatives (Office of the Press Secretary, White House, 2004), federal legislation (Andres, 2006; Domenici, Bingaman, Alexander & Mikulski, 2006), an annual investment of 2.8 billion dollars of federal funds through 207 programs designed to increase the number of STEM students in the United States (United States Government Accountability Office, 2005, p. 1), and is a primary assumption behind the recommendations of advisors to the President of the United States (National Science Board Committee on Education and Human Resources Task Force on National Workforce Policies for Science and Engineering, 2003), a cooperative effort of 18 states to link occupational and academic content in higher education instruction in the areas of

mathematics, language arts, and science in an effort to improve work force preparation (Vocational Technical Education Consortium of States, 2000), and actions of non-profit organizations (Carriuolo, Rodgers & Stout, 2001). It is also a perspective shared by educators and a primary assumption in curricular planning (Forman & Steen, 2000, McCarty, 2003; Perso, 2003) including that practiced in higher education (Fitzsimmons, 2001; Langtry, Coupland & Moore, 2003).

The societal background of this study has its roots in the connection between mathematical skill sets and success in computation, analysis, and synthesis tasks which are required for financial transactions, management of physical resources, use of technology, and design and production at all levels. The importance of this connection is presently evidenced in the increase in technological acumen required in the general life experiences of the populace and in their areas of employment. It is also so widely recognized that it is an assumption behind many actions taken in our society at large and in the field of education. The societal background of the study positions it to address a critical concern in American higher education, a concern Darken (1995), McCabe and Day (1998, p. 9) and the BHEF (2005, p. 5) consider a societal imperative as the development of a baseline set of mathematic skills is believed to be a pre-requisite for educational advancement and employment.

Philosophical Background

The philosophical background of the study is associated with the nature of community colleges. Community colleges are open enrollment institutions with an “equity agenda” (Bailey & Morest, 2007, para. 1). They seek to increase access to higher education for all persons. This aspect of the community college mission significantly

impacts the characteristics of the student population and positions community colleges as a primary conduit of developmental education.

Community college student populations include remarkable diversity in student demographics, skill level, and educational goals as a result of the open access “equity agenda” (Bailey & Morest, 2007). In respect to skill level, a primary focus of developmental education, these institutions enroll students who meet the least restrictive of access requirements for higher education, a high school diploma or GED. As a result, community college student populations include individuals with limited prior academic success, with limited English proficiency, with retraining needs, with a wide variety of personal learning agendas, with family commitments which limit the time and resources these students have for their education, and many students who are employed full time (Phillippe & Sullivan, 2005). These factors limit or restrict the access these students have to four year institutions and the applicability of the programming at four year institutions to the educational goals of the students. To address the needs of this population, community colleges offer flexible scheduling, low tuition and financial aid, academic support services, instruction in English as a second language, pre-college course work, day care, other general support services and instruction at all levels from GED courses through second year college curriculum. Notable among these are courses providing a bridge between present skill level of post secondary students and college entry level skill. The generally accepted phrase to describe these courses is developmental education. 40% of community college students were enrolled in courses of this type in 1995 (National Center for Educational Statistics [NCES], 1998, p. 3), 42% in 2000 (Parsad & Lewis, 2003, p. 17), while 21% and 20% of students in public four year institutions were

enrolled in developmental courses in these years (Boulard, 2004, p. 7). It should be noted that these are enrollment figures not descriptions of the level of need. In respect to need, “It is estimated that up to 61% of all first-time community college students are assessed as underprepared for the academic demands of college-level courses, and the numbers are far higher in some settings” (Community College Leadership Program, The University of Texas at Austin, 2007, p.4). These figures illustrate the distinctive nature of the community college student population in respect to developmental education. The open access philosophy of community colleges predisposes them to serving a population with a wide variety of needs and a much higher percentage of need for developmental education than the student populations of four year institutions.

That community college student populations show the greatest need for developmental education has been acknowledged for decades. 2.4 million students entered American higher education in the year 2000 (McClure, 2000, p. 26). 28% of these students required developmental education (McClure, 2000, p. 26). Nearly one million of the students new to higher education were enrolled in community colleges (McClure, 2000, p. 26). The enrollment in developmental education among the community college students was 42% (McClure, 2000, p. 26). This level of need among community college students has remained constant for decades while the actual numbers of students enrolled in these institutions has been rising (Boulard, 2004, p. 7). During the same period the need for developmental studies among students entering public four year institutions declined slightly (Boulard, 2004, p. 7). Among the academic disciplines commonly included in developmental studies programs the most pronounced area of need is developmental mathematics.

The most common need in remediation among community college students is developmental mathematics (Davis, 1999; Puyear, 1998; Schoenecker, Bollman & Evens, 1996). In the 39 community colleges which are part of the Lumina Foundation Achieving the Dream initiative between 61% and 89% of entering students required developmental course work in mathematics (Ashburn, 2007, para. 12). These percentages are not uncommon nor do they represent levels of need exceeding those of the past.

College publications available on ERIC describe developmental mathematics need levels ranging between 20% and 77% of the student population at Texas community colleges (Texas State Higher Education Coordinating Board, 2002), 57% of students at Virginia's community colleges (Curtis, 2002), 61% of students entering Prince George's Community College of Maryland (Seon & King, 1997), 69% of students at Eastern Arizona Community College, 71% at Pinal County Community College in Arizona, and 91%, 91% and 92% respectively at Yuma/La Paz Community College, the Maricopa Community College District, and the Pima Community College District in Arizona (Puyear, 1998). The entire Minnesota Community College System reported an 89.2% need for developmental mathematics among all entering students in 1992-1993 (Schoenecker, Bollman & Evens, 1996). Developmental mathematics has been and remains the most pronounced area of academic need for students entering community colleges. Investigating factors which may affect student success in developmental mathematics is important if for no other reason than the large number of students requiring this assistance.

The philosophical background of the study is open access higher education, the mission of the community college. This philosophical stance leads to a diverse and often

under-prepared student population. The lack of preparedness is most pronounced in mathematics, the discipline in which this investigation was conducted.

Professional Background

The professional background of the study is related to the philosophical background. The large number of students coming to community colleges under-prepared for college level academics creates a professional challenge for educators serving in these institutions. This challenge is especially pronounced in the area of mathematics.

As noted above, more than 40% of community college students in the United States are enrolled in developmental education (NCES, 1998; Parsad & Lewis, 2003). The majority of these students require developmental mathematics. 89.2 % of the first year students in the two year college system in the state of Minnesota required developmental mathematics instruction in 1992-1993 (Schoenecker, Bollman & Evens, 1996, p. 11) while 61% to 92% of entering students, percentages varied from district to district, required developmental math in the colleges of the Arizona Community College System (Puyear, 1998). Prince George's College in Maryland reported between 57% and 65% of incoming students required developmental mathematics between 1992 and 1996 (Prince George's Community College Office of Institutional Research and Analysis, 1996, p. 3), totals which included a need for developmental mathematics by between 53% and 61% of the entering students who were recent high school graduates (Prince George's Community College Office of Institutional Research and Analysis, 1996, p. 4). This level of need is found across the United States (Texas State Higher Education Coordinating Board, 2002; Waycaster, 2001).

Not only is the need for developmental mathematics present in the community college student population across the United States, the success rates for these students in developmental mathematics are low across the United States. 50% or less of the nearly 16,000 students in developmental mathematics at Rio Hondo College in California passed between 1996 and 2001 (Maack, 2002, p. 11). At Patrick Henry Community College in Virginia, a 55% passing rate was reported in developmental mathematics (Ashburn, 2007, para. 25). 58% of the students in developmental mathematics in the Maricopa Community College District of Arizona pass courses (Maricopa Community College District, 2000, p. 2). Prince George's College of Maryland reported success rates between 44% and 48% overall with passing rates as low as 28% in some sections of developmental mathematics (Seon & King, 1997, p. 2). Between 1990 and 1992, the Florida Community College System reported a system wide passing rate of 52% in developmental mathematics (Fleishman, 1994, p. 26). In the Virginia Community College System, which has five levels of MAT, passing rates were as low as 29% in the lowest level course and as high as 64% in the highest level course between 2002 and 2004 (Waycaster, 2001, p. 410). In Arizona, Navajo Community College reported a 37% passing rate overall, Mohave Community College 56% at its lowest level of developmental mathematics (Puyear, 1998, pp. 4-5) and Pima Community College 51%, 52%, and 58% across three levels of remedial math (McGregor & Attanasi, 1996, p. 16). In 1992, Johnson County Community College of Kansas reported some remedial mathematics courses with passing rates as low as 40% (Seybert & Stoltz, 1992, p.7). Low student success rates, given the volume of students requiring developmental mathematics,

are a professional concern which some educators consider a professional crisis (McCabe & Day, 1998, p. 9).

The professional background of the study is the challenge faced by community colleges in respect to students under-prepared for college level mathematics. A high percentage of community college students fall in this category. Many of these students are not successful in developmental mathematics presenting community college educators with challenges related to accomplishing their educational mission and, therefore, a challenge retaining students. This study increased the knowledge base regarding influences on the success rates of students in developmental mathematics thereby addressing a significant professional challenge faced by community college educators.

Research Background

This study investigates an aspect of an historic concern in higher education, remediation of academic deficits. Researchers trace the roots of developmental education through various forms of academic remediation in American higher education (Arendale, 2002b.; Boylan, 1999; Higbee, 1996; Stephens, 2003). Some seek to connect the present practice to tutoring offered for Harvard students in the early 1600's (Arendale, 2002b). However, the University of Wisconsin is generally credited with initiating the modern approach to addressing academic deficits among students in higher education when, in 1849, it began its preparatory program (Arendale, 2002b; Boylan, 1999; Stephens, 2003). The present phrase describing similar programming, developmental education, and the conceptions associated with it did not come into common use until the 1970's and arose from the expansion of knowledge related to human growth and development experienced

at that time (Boylan & Bonham, 2007, p. 2; Higbee, 2002, p. 28). Developmental education includes all disciplines in which students require remediation. The most common of these are reading, writing, and mathematics.

The literature in the field of developmental education has focused on topics other than the impact of faculty characteristics on student outcomes. Topics addressed in the literature include the history of developmental education (Arendale, 2002; Arendale, 2002b; Boylan, 1999; Lundell & Higbee, 2002; Stephens, 2003), the nature of developmental education (Bruch, 2001; Casazza, 1999; Higbee, 1996; McCabe & Day, 1998), the philosophy behind (Davis, 1999; Lundell & Higbee, 2001) and need for developmental education (Boulard, 2004; Boylan, 1999; McClure, 2000; NCES, 1998; Parsad & Lewis, 2003), policy development (Coscia, 1999; Daughtry-Brian, Fox & Wieland, 1993; Lyons, 1994) and surveys of policies in the field (Brown, 2003; Geller, 2004; McGehee, 1999; Ross, 1980; Wacek, 2002; Wilder, 1991), documentation of the nature of (Hall & Ponton, 2005; Walker & Plata, 2000) and outcomes for students in developmental studies (Burley, Butner & Cejda, 2001; Cunningham, 1995; Wheland, Konet & Butler, 2003), and best practices literature (Higbee & Dwinell, 1995; Panitz, 2007). The literature also includes a small number of studies considering the impact of faculty characteristics on student outcomes.

A limited number of studies have addressed characteristics of faculty in developmental mathematics, some seeking association of these and student outcomes. All such studies found by this author were derived from dissertation projects.

Nine dissertations were completed between 1994 and 2006 which considered developmental mathematics and student outcomes. In 1994, Barker described the impact

of the faculty use of calculators, manipulatives, and programmed instructional support on student outcomes in developmental mathematics. In 1996, Klein compared instructor perceptions of their own teaching efficacy with student outcomes while Penny included a comparison of faculty employment status with student outcomes in her investigation in developmental mathematics. Gross completed a dissertation considering faculty attitude toward teaching developmental mathematics and student outcomes in 1999. In 2002, Hewitt investigated whether “significant differences in academic achievement existed between developmental mathematics students whose instructors were of either full-time or part-time status” (Hewitt, p. iv). Her study included 19 instructors and 1,885 students (Hewitt, 2001, p. iv). Bedard, Christian and Simpson completed a collaborative, Action Research dissertation in 2002 (Simpson). It considered the effectiveness of community college instruction, institutional support of instruction, and a teacher development program created in cooperation with the researchers. Data was gathered across three years at two California community colleges. Morris’ 2004 dissertation considered the “attitudes held by developmental mathematics instructors in Texas community colleges toward developmental mathematics programs and students and the extent of the effect [the] attitudes have on students success” (p. iv). Fike’s 2005 dissertation described the impact of class schedule and instructor employment status on student outcomes in developmental mathematics. And in 2006, Smith surveyed community college developmental mathematics instructors and mathematics department chairs in the state of Tennessee regarding the use of calculators in developmental mathematics. Her results included a description of the typical developmental mathematics instructor in the state of Tennessee. None of these studies sought to consider a broad range of faculty

characteristics and their possible impact on student outcomes in developmental mathematics.

The present study advanced knowledge in the field of developmental mathematics and developmental education by researching the impact of faculty characteristics on student outcomes. While it addresses several factors investigated in other settings, it considers them at rural community college, a setting not previously included in the literature regarding the impact of faculty characteristics on student outcomes in developmental education.

Problem Statement

The research topic investigated in the study was the association of instructor traits and characteristics and student outcomes in community college developmental mathematics.

Statement of Problem

The research problem can be stated in the following manner: The purpose of this ex post facto study was to investigate the association of selected personal traits and experiential characteristics of faculty with student success rates in developmental mathematics at a rural North Carolina community college (Creswell, 1994, p. 64).

Independent Variables

The personal traits and experiential characteristics of faculty which served as independent variables were: faculty age, gender, employment status (full time or part time), residence in the county served by the college, instructional experience in secondary education, present employment in secondary education, graduating from a community college, possessing only a bachelor's degree, possession of an undergraduate degree in

Education, possession of an advanced degree in Education, predominant type of mathematics studied in graduate school (Hathaway, 1983), hours of graduate mathematics study, years of instructional experience in higher education, years of instructional experience at the college and academic rank. Each of these variables was investigated in regard to its effect on student completion rates in semester length developmental mathematics courses at a rural community college.

Dependent Variable

The dependent variable in the study was student success rate in developmental mathematics. Success was defined as receiving a passing grade in the course. A lack of success was defined as receiving a non-passing grade or withdrawing from the course. Withdrawals were grouped with non-passing grades for two reasons. Students enroll in courses with the intention of successfully completing them. Withdrawing from the course is falling short of achieving this goal. Second, in the setting in which the investigation took place, many students elect to or are encouraged to withdraw from developmental mathematics courses late in the semester to avoid receiving a non-passing grade.

Null Hypotheses

Each of the independent variables is associated with a null hypothesis. These are as follows.

1. Faculty age is independent of student success rates in developmental mathematics at the college.
2. The gender of faculty is independent of student success rates in developmental mathematics at the college.

3. Faculty employment status is independent of student success rates in developmental mathematics at the college.
4. Faculty residence in the county served is independent of student success rates in developmental mathematics at the college.
5. Instructional experience in secondary education on the part of faculty is independent of student success rates in developmental mathematics at the college.
6. Simultaneous employment at the college and in secondary education on the part of faculty is independent of student success rates in developmental mathematics at the college.
7. Instruction from faculty who graduated from a community college is independent of student success rates in developmental mathematics at the college.
8. Instruction from a faculty person who has not participated in graduate studies is independent of student outcomes in developmental mathematics at the college.
9. Instruction from a faculty person who has an undergraduate degree in Secondary Education is independent of student outcomes in developmental mathematics at the college.
10. Instruction from faculty members who hold graduate degrees in Education is independent of student success rates in developmental mathematics at the college.

11. The type of mathematics studied by faculty members in graduate school is independent of student success rates in developmental mathematics at the college.
12. The number of graduate hours completed in mathematics by faculty members is independent of student success rates in developmental mathematics at the college.
13. A faculty person's cumulative years of instructional experience in higher education is independent of student success rates in developmental mathematics at the college.
14. A faculty person's cumulative years of instructional experience at the college is independent of student success rates in the developmental mathematics courses taught by that faculty person.
15. A faculty person's rank at the college is independent of student success rates in the developmental mathematics courses taught by that faculty person.

Professional Significance of the Problem

As noted above, the research topic investigated in the study was the association of instructor traits and characteristics and student outcomes in community college developmental mathematics. Any existing association is important within higher education due to the numbers of students at community colleges requiring developmental mathematics and the impact this circumstance has on administration and instruction in those institutions.

In a prior section of this chapter, the volume of students requiring developmental education has been described. Nearly one in every two students attending community colleges is enrolled in developmental studies in one or more academic disciplines. In 1995, this translated into 2 million students in developmental studies across the United States (Boylan, 1999, p. 6) or approximately 417,000 new students entering developmental education in community colleges in the year 2002 (McClure, 2006, p. 26). With this many persons active in developmental education at 1,158 community colleges in USA (Phillippe & Sullivan, 2005, p. 16), the impact on institutions is strong in respect to fiscal, administrative and instructional considerations.

The number of students in developmental education affects a primary administrative concern in higher education, overall funding and specific allocation of funds. The state of Florida spent 22 million dollars, 2.67% of the state budget for community colleges, on developmental studies in the 1992-1993 school year (Fleishman, 1994, p. 62). In the same year, the Minnesota Community College System invested 8.9% of its budget in developmental education (Schoenecker, Bollman, & Evens, 1996, pp. 3-4). In a survey of costs of developmental education in the United States, Saxon and Boylan found that dollar amounts in 1995-1996 ranged from a low of 1.4 million dollars in Kentucky to a high of 172 million dollars in Texas with an estimated national total of 1 billion dollars invested annually (2001, p. 3). The total funding package and discipline specific funding allotments of community colleges are impacted by the presence of developmental education.

Additional administrative concerns, from accomplishing the college's mission to recruiting and training faculty, are impacted by developmental instruction. The mission

of the community college is challenged by the presence of developmental education. As noted above, community colleges are open enrollment institutions with an “equity agenda” (Bailey & Morest, 2007, para. 1). That is, they seek to provide access to higher education for all citizens. The large numbers of students with developmental education needs coming to community colleges for higher education challenges this access agenda. Without success in courses which are designed to prepare one for college level studies, higher education becomes inaccessible blocking the “equity agenda” (Bailey & Morest, 2007, para. 1).

Planning and facilitation of developmental education programs is a critical administrative concern. Recruiting faculty and investing in the maintenance and refinement of their skills is a central administrative activity at institutions of higher education. Understanding which faculty characteristics are associated with student success in developmental mathematics, the focus of the study described, could influence the methods and goals of recruitment and training of faculty members at colleges and universities across the United States.

The professional significance of the study in respect to instruction can also be seen in the number of students under-prepared for college level instruction and the resulting number active in developmental education. Instructional offerings capable of serving the needs of over 40% of active students and designed to provide remediation for over 60% of enrollees are very large undertakings. The combined efforts of administrators, faculty and staff are necessary to craft and maintain such large instructional undertakings. Given the numbers of students enrolled in these courses, developmental education is the largest area of academic specialization at community

colleges. Research with the potential to increase the base of knowledge related to 40% of the undertaking of an institution has tremendous significance.

This investigation of impacts on student success in developmental mathematics has professional significance based upon fiscal, administrative and instructional considerations. In addition, the professional significance of this investigation is found in its unique nature. It is one of the first studies to consider the proposed topic. Little research has been done regarding faculty serving in developmental education. This study advanced the knowledge base related to faculty in developmental education and the impact their personal traits and experiences have on student outcomes.

These administrative and instructional concerns, funding, mission, staffing, professional development for faculty, the primacy of the undertaking in respect to number of students involved, and the opportunity to increase the understanding of the impact of faculty characteristics on student outcomes make up the professional significance of this study.

Summary

This dissertation considers the impact of the personal traits and experiential characteristics of developmental mathematics faculty on student success rates in developmental mathematics. In this chapter, key terms used throughout the document have been defined, the background of the study was discussed, a statement of the problem was provided and the significance of the problem was described. Considerations of the relevant literature, the methodology of the study, the results of the investigation and a summarization of the study and its applications and implications follow.

CHAPTER 2 – LITERATURE REVIEW

This dissertation addresses a concern common to all regions of the United States, all institutions of higher education, and to the future of the American work force, student success rates in developmental mathematics. The review of the literature which follows is a selective review rather than a comprehensive review of the literature. A comprehensive review of the literature of developmental education is beyond the scope of this dissertation as developmental education is a field which includes multiple academic disciplines, has a number of professional organizations, and which has an expanding corpus of literature. An architecture of the literature of developmental education developed by the researcher is employed to provide information regarding the general nature of literature of developmental education in the following. In addition, the description of the scope and nature of the literature will include sufficient background in the history of developmental education to allow the reader to understand the position this area of practice holds within higher education. These topics will be followed by a description of the literature related to developmental mathematics and, finally, a description of the literature focused on the independent variables in this study, characteristics of developmental mathematics faculty.

The Scope and Nature of the Literature of Developmental Education

Developmental education is a young discipline even though it has roots in services provided to under-prepared students at institutions of higher education for over 150 years (Arendale, 2002a; Arendale, 2002b; Neuburger, 1999). The phrase developmental education was created in the 1970s (Arendale, 2002a) based on the

expansion of knowledge regarding human growth and development which occurred during that period (Boylan & Bonham, 2007; Dotzler, 2003).

The organizations for practitioners and the publications in the field are between 30 years and 40 years old (Armington, 2003; Boylan & Bonham, 2007; Clowes, 1980). It was in 1976 that the National Center for Developmental Education was established at Appalachian State University with funds from the Kellogg Foundation (Boylan & Bonham, 2007). The center produced the first edition of the *Journal of Developmental Education* (JDE) in 1978 (Boylan & Bonham, 2007). It was the second major publication in the field of Developmental Education. The first was the *Journal of College Reading and Learning* (JCRL) which was first released in 1969 (Boylan & Bonham, 2007). Another significant event for developmental education which occurred in 1976 was the founding of the National Association for Developmental Education (Boylan & Bonham, 2007). The publications above, JDE and JCRL, remain two of the six primary publications in the field. The others are *Research & Teaching in Developmental Education* (RTDE), founded in 1979, *Research in Developmental Education* (RiDE), first circulated in 1983, *The Learning Assistance Review* (LAR), founded in 1996, and the monograph and digest series of the National Association for Developmental Education (NADE). The first issue of latter was published in 1996 (Boylan & Bonham, 2007).

Even though professional organizations and publications have arisen in the last 30 years, the nature and scope of developmental education is an item of continuing debate (Bruch, 2001; Cassaza, 1999; Davis, 1999; Higbee, 1996). No hierarchical system showing the relationships between various constructs has been developed for the field. In addition, meta-analytical studies and extensive critical reviews of the literature of

developmental education are few in number (Appendix A). Therefore, the statements made by authors in the field describing the literature are brief and subjective or, most commonly, are based upon a topic specific sampling of the literature (Kinney, 2004; Trenholm, 2006; Vasquez, 2000; Wheland, Konet & Butler, 2003). This circumstance did not allow the researcher to identify the emphasis placed on developmental mathematics in the literature of developmental education. In addition, he was unable to portray the balance between this emphasis and that given other critical concerns in the field of developmental education. To facilitate characterizations of these types, the researcher developed an architecture of the literature of developmental education.

An Architecture of the Literature of Developmental Education

The architecture of the literature is attached to this dissertation in the form of an appendix. This appendix details the method employed in developing the architecture which is based on 796 articles or dissertations published between 1980 and 2007. Excluding the dissertations used, this material was published in four of the six major publications in the field. These are JDE, RiDE, RTDE and the NADE monograph and digest series. As a result of this work the following statements can be made about the literature of developmental education.

Foci of the Literature of Developmental Education

The general nature of the literature of developmental education is as follows. It has three primary topic areas. These are “Developmental Education Programs,” “Perspectives of Developmental Education” and “Resources for Developmental Education.” Occasionally authors write articles which include emphasis in two or even three of these areas. To account for this, the architecture of the literature has a fourth

primary heading, “Mixed Content” (Appendix A). Consideration of developmental programs is the bulk of the literature accounting for between 76.4% and 97.6% of the material published. Articles related to perspectives of developmental education account for between 2.4% and 13.4% of the material and those describing resources for developmental education account for between 0% and 16.3% of the material in JDE, RiDE, RTDE and the NADE monograph and digest series (Appendix A). There is little content in the literature that straddles two or three of the primary topic areas, two of the publications have none and the other two contained 0.2% and 1.0% (Appendix A). This is evidence that the primary topic areas employed in the architecture are accurate representations of main constructs in the literature.

The topic area in developmental education receiving the most consideration by authors is developmental programs accounting for between 76.4% and 97.6% of the material published in four of the six major publications in the field (Appendix A). This topic area includes content related to the persons or participants in developmental education, administration and supervision of developmental education, educational theory and practice, and equity, access and balance issues (Appendix A). The most commonly addressed category in this group is educational theory and practice comprising between 44% and 56% of the articles in the four publications used to develop the architecture (Appendix A). Like some other categories in the architecture, educational theory and practice is divided into subcategories. The subcategory of educational theory and practice which includes information concerning specific academic disciplines is the largest subcategory of the architecture (Appendix A).

Content area or academic discipline specific considerations (i.e. Reading, English, Mathematics, Reasoning/Critical Thinking) are the largest subcategories in the literature. Between 21% and 40% of all the articles published in the periodicals used to develop the architecture focus on content area specific applications (Appendix A). Of the publications considered, RTDE has focused most heavily on this subcategory with 56.5% of all the content sampled classified in this subcategory (Appendix A).

The focus on content area specific considerations is, in the opinion of prominent authors in the field, a product of the nature of the field (Chung & Brother, 2002). The vast majority of persons active in the field are practitioners who specialize in providing instruction within a given content area or academic discipline. That the focus of these persons is predominantly educational theory and practice especially as it relates to the academic discipline in which they teach should be expected. The breadth of topics considered in and primary topics associated with each publication is also revealed in the architecture and is described in the attached appendix (Appendix A).

Literature Regarding Developmental Mathematics

Relationship to the Literature of Developmental Education

One of the most common content areas of developmental education is developmental mathematics. This subject area is included in the architecture of the literature under the main heading Developmental Education Programs, the category Educational Theory and Practice, the subcategory Content Area Theories of Action/Applications and the label Mathematics (Appendix A). Articles directly addressing developmental mathematics have been the focus of between 3.1% and 10.6% of the material published in developmental education and this topic been repeatedly

discussed in each of the publications used to form the architecture (Appendix A). Information regarding this topic area is also addressed in other parts of the literature of developmental education, most notably under the heading Developmental Education Programs, the category Administration and Supervision, and the subcategories Goals and Outcomes and Policies and Processes. This is the case as the goals and outcomes of developmental education programs include measures of success in academic disciplines in which developmental studies are offered, developmental mathematics being one of these, and because the policies and processes of institutions of higher education include planning for developmental mathematics.

The Literature Surveyed

The sources used to construct the following summary of the literature of developmental mathematics were drawn from leading publications in the field. They include all but two of the articles about developmental mathematics published in RiDE since its first issue in 1983, every article about developmental mathematics published in JDE in the last decade and others from before that period, every article regarding developmental mathematics in RTDE from 1998 through 2006, and every article about developmental mathematics published by NADE in its monograph and digest series. They also include works accessed from the Educational Resources Information Center database, the Academic Search Premier database, the Education Research Complete database and the Dissertation Abstracts International database and works accessed on the websites of NADE, the Chronicle of Higher Education, the Center for Research in Developmental Education and Urban Literacy, the League for Innovation in the Community College, the National Center for Developmental Education, and the Center

for Community College Policy. The earliest article included in this review is from 1984. The most recent was published in the fall of 2007.

Characteristics of the Literature of Developmental Mathematics

The literature of developmental mathematics addresses a variety of topics. As such, it is possible to describe the general characteristics of the literature in this area of developmental instruction. It is also possible to describe attention given to specific topics. One of the topics within the literature of developmental mathematics is the association of faculty characteristics with student outcomes. A discussion of the general nature of the literature of development mathematics and then of the material within that body of literature which focuses on the relationship of faculty characteristics to student outcomes follows.

General Characteristics of the Literature of Developmental Mathematics

The literature of developmental mathematics can be divided into three categories. The first is research literature. The second is descriptive literature. The third is reviews of the literature. Tables 2.1, 2.2 and 2.3 provide the reader lists of articles in these categories. Each table lists the author's name, the year of publication and the topic of the publication. Tables 2.1 and 2.2 group the publications by content and employ the same content headings to facilitate comparison.

Table 2.1

Research articles in the literature of developmental mathematics

Category, author and date	Subject matter
<i>1. National</i>	
MacDonald (1988)	National survey of developmental math programs
<i>2. Program evaluation</i>	
Werner (1987)	Evaluation of a college developmental math program
Brasher & Dwinell (1992)	Evaluation of a college developmental math program
Waycaster (2002)	Evaluation of five Virginia developmental math progr's
<i>3. Instruction</i>	
Koch (1992)	Instruction in constructivist pattern
Grossman, Smith & Miller (1993)	Relationship writing about math and course grade
Lesnak (1993)	Relationship writing about math and course grade
Glover (1995)	Relationship gender + testing method and student outcome
Stratton (1996)	Impact paired classes on student outcome
Graves (1998)	Impact active context based learning on student outcome
Weems (1998)	Impact of homework collection on student outcome
Gray (2000)	Student use of prose and tabular information
Best & Fung (2001)	Impact of new course design on student outcome
Glover (2002)	Comparison hybrid and online course outcomes
Kinney & Kinney (2002)	Perceptions of computer and classroom math instruction
Schurter (2002)	Impact comprehension monitoring instruction on outcomes
Vasquez & McCabe (2002)	Impact of calculator use on student outcome
Wright, Wright & Lamb (2002)	Impact of Supplemental Instruction on student outcomes
Jacobson (2005)	Impact e-mail reminders on attendance and test grades
Coe (2006)	Review courses impact student outcomes
Phelps & Evans (2006)	Impact of Supplemental Instruction on student outcomes
Jacobson (2006)	Impact computer based support on student outcome

Table 2.1 continued

Research articles in the literature of developmental mathematics

Category, author and date	Subject matter
<i>4. Outcomes</i>	
Short (1996)	Curricular outcomes for former devel. math students
Higbee & Thomas (1999)	Relationship non-cognitive variables and acad. achieve
Walker & Plata (2000)	Relationship race/gender/age with student outcome
Kinney (2001a)	Comparison student outcomes CBI and lecture courses
Weems (2002)	Compare student outcome online and lecture sections
Efrid (2005)	Compare outcomes devel. math and no devel. math in curr. programs
Duranczyk (2007)	Short- and long-term effects of developmental math
<i>5. Faculty</i>	
Penny & White (1998)	Impact stud. and fac. characteristics on stud. outcomes
Wheland, Konet & Butler (2003)	Impact stud. and fac. characteristics on stud. outcomes
Galbraith & Jones (2006)	Case study of a 25 year old developmental math instructor
<i>6. Students</i>	
Umoh & Eddy (1994)	Impact student characteristics on retention in devel. math
Caniglia & Duranczyk (1999)	Math beliefs of developmental mathematics students
Johnson & Kuennen (2004)	Students who delay devel. math and outcomes for them
Kinney, Stottlemeyer, Hatfield & Robinson (2004)	Compare student attitudes/attributes in CBI and lecture
Hall & Ponton (2005)	Compare math self-efficacy in devel. math and calculus
Duranczyk, Goff & Opitz (2006)	Student use and perception of math center
Wadsworth, Husman, Duggan & Pennington (2007)	Student learning strategy and self-efficacy in online crs

Table 2.2

Descriptive literature in developmental mathematics

Category, author and date	Subject matter reviewed
<i>1. National</i>	
Cohen (1993)	Working draft of national standards curriculum reform
<i>2. Local program/policy</i>	
Thomas & Higbee (1995)	Report regarding devel. math reform at Georgia State
Weinstein (1995)	Learning strategies course as supplement to devel. math
Warner, Duranczyk & Richards (2000)	Organizing principles of a success develop. math progr.
Brittenham, et al. (2003)	Description of developmental programming at a univ.
Garcia (2003)	Development of an Elementary Algebra course
Gunthorpe (2006)	Description of developmental programming at a CC
<i>3. Instruction</i>	
Stepans (1984)	Inductive discovery method of instruction
Vukovich (1985)	Student journals as instruction tool in devel. math
MacDonald (1989)	Principles of assessment applied to developmental math
Benander, Cavanaugh & Rubenzahl (1990)	Team building as part of a devel. studies program
Darken (1991)	Reform suggestions for devel. math based upon K-12
Gray (1991)	Ways to teach metacognition in devel. mathematics
Key (1992)	Cooperative learning in developmental mathematics
Garland (1993)	Cooperative learning and multi-culturalism in devel. math
Nicewonder (1994)	Humor as an instructional tool in developmental math
Darken (1995a)	Project to develop standards for introductory math curricula
Darken (1995b)	Project to develop standards for introductory math curricula
Perdew, Preston-Sabin & Hodge (1995)	Writing project as instructional method in devel. math
MacDonald & Caverly (1999)	Evolution of mathematics instructional software
Kennedy (2000)	Use of physical models/manipulatives to develop reasoning
Miles (2000)	Innovative mathematics instruction
MacDonald, Vasquez & Caverly (2002)	Use of calculators, Excel and the Web in devel. math

Table 2.2 continued

Descriptive literature in developmental mathematics

Category, author and date	Subject matter reviewed
<i>3. Instruction – continued</i>	
Rodriguez (2002)	Understanding self-efficacy to improve service to students
Hodge (2003)	Teaching logic in developmental mathematics
Tanner (2005)	Games as an instructional tool in developmental math
Di Muro (2006)	Teaching methodology for developmental mathematics
Shields (2007)	Understanding math anxiety and how to address it
<i>4. Outcomes</i>	
No publications	
<i>5. Faculty</i>	
No publications	
<i>6. Students</i>	
<i>7. Philosophy/theory of practice</i>	
Kinney (2001b)	Wambach, Brothen & Dikel’s theory applied in devel. math

Table 2.3

Reviews of the literature in developmental mathematics

Author and date	Subject matter
Gourgey (1992)	Tutoring and developmental mathematics
Farrelly (1996)	Writing as instruction in developmental mathematics
Morrison & Payne (2000)	Social factors impacting attitudes of adult math students
Vasquez (2000)	Calculator usage in developmental mathematics
Trenholm (2006)	Efficacy of computer mediated developmental mathematics
White & Harrison (2007a)	Dissertations written in developmental education
White & Harrison (2007b)	Dissertations written in developmental education

In general, the literature of developmental mathematics includes a number of focuses. National surveys and reports from national task forces are represented. Descriptions and evaluations of local programs or a number of local programs represent a significant portion of the literature. Nine of the 68 articles on Tables 2.1 and 2.2 fit in this category. However, considerations of instruction, both research regarding it and descriptions of instruction, are the bulk of the literature of developmental mathematics. All but two of the reviews of the literature directly and exclusively address instruction and the two which don't exclusively address instruction consider dissertations that focus on instruction. When the reviews are grouped with the 39 articles directly addressing instruction found on Tables 2.1 and 2.2, 46 of the 75 articles included in this review address instruction. The remaining general topics in the literature are outcomes of developmental mathematics, developmental mathematics faculty, students in developmental mathematics, and philosophical concerns as related to developmental mathematics.

Relating Faculty Characteristics to Student Outcomes in Developmental Mathematics

There is little specific information about developmental faculty and the effect their characteristics have on student outcomes in the literature of developmental mathematics. Of the research articles listed in Table 2.1, only McDonald (1988), Penny & White (1998), Waycaster (2002) and Wheland, Konet and Butler (2003) include descriptions of faculty characteristics and only Penny & White (1998) and Wheland, Konet and Butler (2003) consider the characteristics as independent variables in research. None of the 29 descriptive articles listed on Table 2.2 include considerations of faculty or their characteristics. Only the two reviews of recent dissertations out of the seven

literature reviews listed on Table 2.3 include considerations of faculty and then only in a limited number of the dissertations described. That faculty characteristics are infrequently considered in the literature of developmental mathematics is a product of a number of characteristics of the literature. The literature of developmental education, in general, and developmental mathematics is pragmatic practitioner's literature as opposed to a research corpus. In addition, the research literature of developmental mathematics often is not robust and, since it is conducted primarily by developmental education faculty in classroom or departmental settings, it is focused on student characteristics, student outcomes and instructional patterns.

That the literature of developmental education is predominantly pragmatic practitioners' literature rather than research corpus can easily be demonstrated as can the presence of this characteristic in the literature of developmental mathematics. Between 44% and 56.5% of the articles published in developmental education literature pertain to educational theory and practice (Appendix A). As the largest percentage of the literature of developmental education focuses on the theory and practice of instruction, it is predominantly practical, instruction oriented literature. This characteristic extends to the literature of developmental mathematics as 39 of the 68 articles listed on Tables 2.1 and 2.2 address instruction. "Disciplinary-specific models...of developmental educational practice which emphasize practical, pedagogical issues are the norm" (Lundell & Collins, 1999, p. 7) in the literature of developmental education.

The research chronicled in the literature of developmental mathematics has not "reached a level of attainment commensurate with the needs of the profession" (O'Hear & MacDonald, 1995, p. 4). The research conducted is predominantly quasi-experimental

classroom research performed in a single semester (Best & Fung, 2001; Glover, 1995; Glover, 2002; Grossman, Smith & Miller, 1993; Jacobson, 2005; Jacobson, 2006; Koch, 1992; Lesnak, 1993; Schurter, 2002; Stratton, 1996; Vasquez, 2002). The most conscientious of these studies include multiple class sections in the experimental and control cohorts (Best & Fung, 2001; Glover, 1995; Glover, 2002; Jacobson, 2005; Jacobson, 2006; Lesnak, 1993) however samples that are too small to be representative are not uncommon (Glover, 2002; Weems, 2002). Establishing reliability and validity through replication is rare in the published developmental mathematics research. Only three of the studies included in this review, those of Coe (2006), Phelps and Evans (2006), and Wright, Wright and Lamb (2002), include this pattern. Longitudinal studies and studies with large samples are also uncommon. Of the studies listed on Table 2.1, only those of Caniglia and Duranczyk (1999), Penny and White (1998), Galbraith and Jones (2006) and Wright, Wright and Lamb extended for two years (2002) while Coe's work extended across six years (2006). This amounts to less than one third of the published research included in this review. Excluding the considerations of programs and qualitative studies, only eight of the 35 studies in Table 2.1 included samples larger than 200 students (Coe, 2006; Efrid, 2005; Johnson & Kuennen, 2004; Kinney, 2001; Penny & White, 1998; Short, 1996; Walker & Plata, 2000; Wheland, Konet & Butler, 2003) with quantitative studies considering between 20 and 50 students present (Higbee & Thomas, 1999; Stratton, 1996; Weems, 2002). In addition, few of the authors considered the potential impact of confounding factors on their studies or sought to limit their impact. Further, the research literature of developmental mathematics is often statistically

unsophisticated. It provides descriptions of programs, circumstances and outcomes without inferential analysis.

Waycaster's 2002 review of the developmental programs at five Virginia institutions and other studies can serve as an example of the low level of statistical analysis common in the literature of developmental mathematics. Only descriptive statistics are used. These statistics are portrayed in cross tabulation tables. The discussion of the results is comprised of descriptive comparisons rather than analytical content. The same can be said of McDonald's review of the results of a national survey (1988), Wepner's evaluation of a program (1987), Best and Fung's report on a pilot program (2001) and Vasquez's study of patterns of calculator use (2002). Even White and Harrison's reviews of recently published dissertations in developmental education only summarize the studies rather than offering meta-analysis (2007). There appears to have been little change since O'Hear and MacDonald wrote

“Methodology employed in developmental education research does not seem to have reached a level of attainment commensurate with the needs of the profession. The review reported here exposes a critical need for researchers to be more familiar with standards for designing research studies, more cognizant of the limitations of the research which is reported, and more careful in formulating implications for both research and practice” (1995, p. 4).

These characteristics and those described above limit the value of most of the studies published in developmental mathematics and they reflect the practical and instruction oriented character of the literature.

This practical instruction focused body of literature has very few considerations of faculty. While Higbee and Thomas note that research in developmental mathematics is shifting from a focus on “learner characteristics to a more integrated approach, with a greater emphasis on the role of the teacher and course content and structure and how these factors are related to learning” (1999, p. 9), the literature remains predominantly concerned with student characteristics, student outcomes and instructional patterns. Of the 38 research articles listed in Table 2.1, 35 do not include considerations of faculty characteristics. None of the 29 articles descriptive articles listed on Table 2.2 include considerations of faculty or their characteristics. Only two of the seven literature review articles listed on Table 2.3 address faculty in developmental education. The characteristics of the faculty teaching developmental education and the impact those characteristics might have on students has not been a primary focus of the literature of developmental mathematics.

The few articles that consider the topic of this study provide limited information. The work of McDonald (1988) and Waycaster (2002) has very limited or no applicability to the present study. The reviews provided by White and Harrison (2007) describe only five dissertations which have applicability for the present investigation. A number of these were conducted in developmental mathematics and refer to several of the independent variables in this investigation. Only Penny and White (1998) and Wheland, Konet and Butler (2003) have published articles describing investigations of constructs with direct application to the present study.

While outdated, the work of McDonald (1988) could have served as a point of comparison if it had addressed faculty characteristics in any depth. However, this was not

the case. The only information applicable to the present study is the fact that few institutions offered faculty the choice to teach developmental mathematics or rotated teaching assignments for faculty teaching developmental mathematics (McDonald, 1988, p. 14).

Waycaster could also have provided valuable descriptions of faculty and tested the relationship between faculty characteristics and student outcomes but did not (2002). Her study included the gender of instructors, the courses each taught, the format each instructor elected to employ in teaching the course and the average number of questions asked per class by instructors (Waycaster, 2002). This information would have made several comparisons of impact on student outcomes possible but these comparisons were not conducted. This was not caused by a lack of data regarding students. Waycaster documented student demographics, the average number of questions answered by each gender in class, and student passing rates in developmental mathematics plus the student success rate in subsequent college courses, retention rate and graduation rate (Waycaster, 2002). This data provided the potential for numerous points of comparison with faculty characteristics. However, only cross-tabulation of faculty characteristics and student outcomes was completed (Waycaster, 2002). Waycaster's work is of no value to the present study.

White and Harrison reviewed, in a two part series, dissertations regarding developmental education published between 2002 and 2006 (2007a; 2007b). Many of the dissertations described are not applicable to this study as they surveyed developmental programs and policies, focused on developmental reading and English, or considered the impact of computer based instruction and online instruction. A number of dissertations

reviewed were conducted in developmental mathematics but addressed student characteristics or institutional outcomes for former developmental mathematics students. Only four of the dissertations included described characteristics of faculty in developmental education and one described the relationship of faculty attitude and students outcomes in developmental mathematics. These dissertations provide information applicable to the present study.

In 2005 Nolan found inconsistencies between the beliefs and practices of faculty in developmental education (White & Harrison, 2007a, p. 2). He also found that gender, teaching experience in developmental education and training to teach in developmental education impact faculty “perceptions of underprepared students” (White & Harrison, 2007a, p. 2). Kozeracki’s 2004 dissertation described the socialization and integration of developmental faculty in a community college. This qualitative study reported one factor of interest to the present study, part time faculty often receive little support and are not well integrated in colleges (White & Harrison, 2007a, p.2). In 2005, Fike wrote a dissertation considering the impact of class schedules on student outcomes in developmental mathematics (White & Harrison, 2007b, p. 2). His research included comparing faculty employment status and student outcomes. While no significant relationships were found between these two constructs, when employment status was combined with class schedule a statistically significant relationship was found with student outcomes (Fike, 2005, p. 100). In 2004, Morris investigated the relationship of the attitudes of developmental mathematics faculty, employment status, “teaching experience, education level, educational major, preparation for teaching, and specific preparation for developmental education” (White & Harrison, 2007a, p. 3). Morris found

that “specific preparation for teaching developmental education was significantly related to instructor attitudes” (White & Harrison, 2007a, p. 3) and that faculty attitude was related to student success in developmental mathematics (White & Harrison, 2007a, p. 3). Fike and Morris’ studies, included by White and Harrison in their review, are discussed in greater detail below under the heading “Related Dissertations.” The studies noted above are directly related to the present study as they address faculty characteristics, the impact of those characteristics of faculty on students and some of the same variables investigated in the this study.

Among the studies in the literature of developmental mathematics with direct relationships to the present study is that of Penny & White (1998). It was an ex post facto study conducted at three southern universities which included 1,475 students and 44 faculty (1998, p. 2). It sought to

“identify developmental student characteristics that were related to students' performance in their last developmental mathematics course and in their first college-level mathematics course....[and to] identify characteristics of faculty who taught students' last developmental mathematics course that were related to student performance in that course and in the first college-level mathematics course” (Penny & White, 2002, p.3).

A “direct relationship between both teacher employment status and gender and students' performance in the last developmental mathematics course” (Penny & White, 2002, p. 5) was found. “Part-time employment status had a significant, positive direct effect upon students' performance whereas male teacher gender had a significant, negative direct effect” (Penny & White, 2002, p. 5). “The variables age, educational preparation, and

years of teaching experience did not significantly contribute to students' performance in their last developmental mathematics course” (Penny & White, 2002, p. 5). These results are relevant to the present study as they consider some of the same independent variables in a different context.

Wheland, Konet and Butler investigated the relationship between instructor’s who spoke English as their second language, instructor employment status, and student performance in curricular classes and student outcomes in developmental mathematics. In respect to faculty characteristics, they found having a non-native speaker of English as an instructor did not impact student outcomes in developmental mathematics (Wheland, Konet & Butler, 2003, p. 19). They also found that graduate teaching assistants and part time faculty were not significantly associated with differences in student outcomes (Wheland, Konet & Butler, 2003, p. 20). These results are relevant to the present study as the impact of the employment status of developmental mathematics instructors on student outcomes was investigated.

Implications for the Present Study

The literature of developmental mathematics contains very little information helpful for the present study. “Much of the research...produce[d] remains at an applied or assessment level, lacking a connection across the wide variety of subject areas”(Lundell & Collins, 1999, p. 8) and settings in developmental mathematics and developmental education. Among the limited number of implications the literature has for this study is the significance of faculty characteristics on student outcomes. A small but growing number of researchers have found associations between given faculty characteristics and student outcomes. 17 characteristics of faculty with support as influencers of faculty

actions and student performance in the general literature of higher education were investigated in this study. That a number of these, instructor gender, teaching experience in developmental education, faculty employment status, highest level of education by faculty and predominant topic of study, have received consideration in other studies focused on developmental mathematics was of benefit in interpreting the results of the present study. However, these published research results were compared to the results of the present study taking the variation in institution type and definition of student success into account.

Literature Regarding the Impact of Faculty Characteristics

The literature of developmental mathematics includes a limited number of studies addressing the impact of a small number of faculty characteristics on student outcomes. While this establishes the present study as an important and initial investigation in an area of higher education practice, it does not provide a substantial basis of comparison with other investigations of the same constructs. Further, the general literature of developmental education provided no additional sources.

RTDE published no articles about faculty between 1998 and 2006. Only 0.2% of the material in JDE since its first issue addressed developmental faculty. These articles are all descriptive in nature. 2% of the material in NADE publications, a total of two articles, concerned faculty. One of these is a qualitative consideration of an instructor's conception of intelligence and is not applicable to the present study (Maitland, 2001). The second is a qualitative study of faculty perceptions of the instruction they provide in online and classroom sections of developmental mathematics and also is not applicable to the present investigation (Kinney & Kinney, 2002). 4% of the content of RiDE addresses

faculty. Two of these articles describe program staffing patterns in developmental education (Boylan, Bonham, Jackson & Saxon, 1994; Boylan, Bonham, Jackson & Saxon, 1995). The other two describe developmental educators (Boylan, Shaw, Materniak, Clark-Thayer, & Saxon, 2000; Gabriel, 1988). The general literature of developmental education provided no additional sources relevant to the present study.

To address this concern, information regarding the impact of the independent variables for this study had to be drawn from literature regarding faculty in the superset to which developmental education belongs, the field of higher education.

Higher Education Literature Regarding Faculty Characteristics

The literature of higher education includes extensive consideration of the characteristics of faculty, the influences on faculty, the work and work environment of faculty and the impact faculty persons have on students. Examples of book length publications which focus on faculty and their work are found on Table 2.4, a significant number of these address community colleges. Hundreds of dissertations have been written on this topic considering multiple influences on faculty grouped by academic discipline, level of experience, type of institution, highest degree attained, use of instructional modalities and many other characteristics. The volume of periodical literature in this area is also extensive. As a result, a comprehensive review of this literature is beyond the scope and purpose of this dissertation. However, a limited number of dissertations and other sources were selected to provide a perspective from the literature of higher education regarding the independent variables investigated in this study. This was done to supplement the limited volume of information available in the literature of developmental education.

Table 2.4

Examples of publications regarding faculty

Author and date	Title
Roueche & Roueche (1993)	Between a Rock and a Hard Place: The At-Risk Student in the Open-Door College
Braskamp & Ory (1994)	Assessing Faculty Work: Enhancing Individual and Institutional Performance
Baker (1994)	A Handbook on the community college in America: Its history, mission, and manage
Blackburn & Lawrence (1995)	Faculty at Work: Motivation, Expectation, Satisfaction
Cohen & Brawer (2003)	The American Community College
Lail (2005)	Early Career Faculty Perceptions of Their Teaching Preparedness and Professional Development in the North Carolina Community College System
Levin, Kater & Wagoner (2006)	Community College Faculty: At Work in the New Economy
New Directions for Community Colleges journal (Volume 118)	Community College Faculty: Characteristics, Practices and Challenges

The present study sought to understand the relationship between the independent variables investigated and the outcomes for students in developmental mathematics. The assumption behind this investigation is that the personal and experiential characteristics of faculty influence their practice and through that influence student outcomes. This is one of the basic assumptions of higher education and education in general.

That an experienced or educated person can communicate to another person knowledge, skills and attributes based upon his or her experience or education and thereby alter cognitive or non-cognitive outcomes for the second party is the primary assumption behind educational programs and institutions. It is also a documented belief of higher education students, faculty and administrators. The work of Hagedorn, Perrakis and Maxwell with 5,000 students across three years in Los Angeles community colleges demonstrated this from the student perspective (2002) as did the research of Cejda and Rhodes in 2004 and Elliot in 1989, Woerner's 1993 investigation of nursing student opinions and Grosset's 1997 focus group research for Philadelphia Community College. Research and college documents have shown this is the belief of faculty and administrators in higher education. In Elliot's qualitative investigation students, faculty and administrators agreed on the impact of faculty attributes and behaviors (1989). Thompson's research sought to determine whether faculty characteristics were perceived as impacting student outcomes by faculty and administration and found they were (2001), results similar to the work done by Fadale in 1990. All higher education planning related to faculty and instruction includes this assumption. For example, Mount Hood Community College's faculty programming plans express the belief that the experiences and knowledge gained by faculty will be translated into improvements in student success

(Kreider, Walleri & Gratton, 1993). Similar examples include the New York State Education Board's Task Force on Postsecondary Education and Disability publication in 2000 (Walters), the planning documents of Triton College (1981), the recommendations of the National Council of Instructional Administrators of the American Association of Junior and Community Colleges (1992) regarding student success and instruction, the report of the Future Faculty Task Force at Lane Community College (Barber et al., 1995) and scholarly publications in respect to minority faculty like Dawson-Threat's work regarding the influence of Black faculty on Black student racial identity development (1997) and Lewis and Middleton's work about success for Black students in community colleges (2003). As a result of this primary assumption of higher education, the independent variables of the present study have been investigated by researchers in higher education in respect to their influence on faculty and, in many cases, the manner in which that influence was manifested.

In 1993, DuBois found the personal traits of faculty at community colleges influenced their "viewpoints, values, and behavior" (p. ii). In a study at a large university, Grimes reported personal traits of faculty to be the strongest influence on their decision to adopt internet content in instruction (2005). The qualitative investigation done by Woerner found that nursing students ascribed strong influence on students to the values and behavior of faculty (1993). These studies are illustrations of the focus of this study. Faculty characteristics as mediated in decisions and actions impact students. The complex and varied impact of the personal traits of faculty on instruction has been investigated within the United States and in other countries (Struchiner, 1992; Akindahunsi, 1995; Al Saif, 2005). Instructor age, gender, employment status and cultural affiliation or

understanding, personal traits of faculty, have served as independent variables in investigations chronicled in the general literature of higher education. Each has been found to be associated with faculty behavior.

Instructor age has been investigated in many settings and found to have a significant influence on a range of decisions made by faculty. These include global concerns like “instructional paradigm” (Toma, 1997, p. 1), use of instructional platforms (Huang, 2001), and the selection of class instructional content (Helton, 2000). They also include more specific choices like the inclusion of technology in instruction (Gao, 2000), early adoption of technological innovations (Mathew, 2001), and the use of older or newer forms of instructional media (Genanaw, 1999). The specificity within studies of the impact of faculty age has extended to characteristics exhibited by particular age groups. For example, Chu identified 40-50 year old instructors as the most likely to use internet resources (2002). All the areas of influence described above demonstrate the significance of instructor age as it impacts the patterns of instruction and interaction provided by faculty in the classroom. As the premise of this study is that the environmental factor faculty characteristics impacts student outcomes and instructor age has been shown to influence faculty actions in multiple spheres, instructor age was a variable worthy of consideration in its relationship to student outcomes. As a within-institution environmental factor in the Astin I-O-E model (1968; 1976; 1991) and a characteristic which is described in employee personnel records, it was included in the project.

Instructor gender also has been investigated in many settings and found to have significant influence on a range of decisions made by faculty. These include global

concerns like “instructional paradigm” (Toma, 1997, p.1), the identification of teaching goals (Fox, 1997), a student centered approach to instruction (Ngabung, 2001), faculty attitude toward technology (Bullard, 1998), and the selection of class instructional content (Helton, 2000). They also include more specific choices like the use of teaching methods that actively involve students (Einarson, 2001) and the inclusion of interactive video instruction (Skirvin, 1998). These decisions and attitudes impact the patterns of instruction and interaction in the classroom. As the premise of this study is the environmental factor faculty characteristics impacts student outcomes and instructor gender has been shown to influence faculty actions in multiple spheres, instructor gender was a variable worthy of consideration in its relationship to student outcomes. It is also a characteristic available in employee personnel records and, therefore, was included in the project.

The third personal variable investigated was faculty employment status, full time versus part time. Employment status has been shown to impact aspects of faculty behavior. La Nasa reports that employment status is related to the amount of time devoted to teaching (2001). Lei found that the student assessment practices of faculty are differentiated between part time and full time faculty (2003). Hajduk’s findings indicate that employment status is independent of a student centered outlook on the part of faculty (2000). Bailey, Calcagno, Jenkins, Kienzl and Leinbach’s consideration of data from the “National Education Longitudinal Study of 1988 (NELS:88)...[which] follows a nationally representative sample of individuals who were eighth graders in the spring of 1988” (2005, pp. 10-11) revealed that “percentage of part time faculty...[had a] statistically important negative...association with the probability of graduation” by their

students (2005, p. 20). Iadevaia investigating the impact of faculty employment status on student success in general and in science courses at Pima Community College while defining success in the same manner as in the present study (1991, p. v). His research found no statistically significant difference in success rates for student taught by full time and part time faculty (Iadevaia, 1991, p. 81). Yet, Penny and White reported that the employment status of faculty has a significant positive relationship with student performance in and following developmental mathematics at universities (1998). “Part-time employment status had a significant, positive direct effect upon students' performance” (Penny & White, 1998, p. 5). The research project being described can contribute to resolving this set of apparent contradictions. As employment status has been shown to impact faculty instructional behaviors like the time devoted to instruction and student assessment practices and since it has been linked to student performance with a variety of impacts in published studies including one study in developmental mathematics, it was a variable worthy of consideration in its relationship to student outcomes in developmental mathematics at the community college level. It is also a characteristic included in employee personnel files and, therefore, was included in the present study.

That local context and culture impact the work of faculty has been documented in the literature of higher education. Stark (1990) found elements of the local context influence faculty decision making as did Dooris and Fairweather (1994) and Gao (2000) found social relationships impacted faculty actions and decisions. Toma (1999) and Medlin (2001) both reported faculty surveyed stated that society and culture impact the choices they make regarding instruction while Colbeck (2000) discussed the impacts of

local and institutional culture. In respect to specific American subcultures, Kossman's 2003 dissertation considered the impact of cultural differences between White nursing instructors and Black students on student persistence and performance. The differences were found to have an impact. Similar results were found by Hagedorn, Chi, Cepeda and McLain who investigated the relation of the proportion of Latino faculty to success by Latino students in a California community college program (2007). A positive relationship between the proportion of Latino faculty and the success of Latino students was reported (Hagedorn, Chi, Cepeda & McLain, 2007). These results are not surprising as they represent commonly held beliefs and practices in higher education and American society and research documented impacts of cultural differences (Barna, 1991; Dawson-Threat, 1997; Fadale, 1990).

County residence was chosen as a surrogate variable to represent cultural affiliation or understanding. The college which served as the research site is located in North Carolina, an American state in the historic south. That southern culture is a distinct subset of American culture has been documented in research literature for an extended period of time (Gillin & Murphy, 1951; Kilbride, 2000). A sampling of research related to this topic included considerations of its impact on economics (Gillin & Murphy, 1951; Arndt, 2007), values and beliefs (Barna, 1991; Gillin & Murphy, 1951; Goldfield, 1981; Rice & Pepper, 1997; Warren, 2005), personal and social practices (Balthrop, 1984; Barna, 1991; Cohen, Vandello, Puente & Rantilla, 1999; Gillin & Murphy, 1951; Hayes & Lee, 2005; Rice & Pepper, 1997; Smith, 1993; Strobe, 2007), social stratification (Balthrop, 1984; Buckley, 1997; Gillin & Murphy, 1951; Smith, 1993; Warren, 2005), family and kinship (Barna, 1991; Gillin & Murphy, 1951; Hayes & Lee, 2005),

perspective of history (Balthrop, 1984; Smith, 1993; Morris, 1990), housing (Gillin & Murphy, 1951; Goldfield, 1981), diet (Gillin & Murphy, 1951; Burrison, 2003), labor practices (Gillin & Murphy, 1951; Goldfield, 1981), recreation (Carmichael, 2005; Gillin & Murphy, 1951), education (Carmichael, 2005; Gillin & Murphy, 1951; Richardson & Wilcox, 1994), attitudes about and practice of sex (Gillin & Murphy, 1951; Rice & Pepper, 1997; Strobe, 2007), traits exhibited by racial groups (Balthrop, 1984; Fields et. al., 1998; Gillin & Murphy, 1951; Hayes & Lee, 2005; Huff-Corzine, Corzine & Moore, 1986; Rice & Pepper, 1997; Royster, 1993; Smith, 1993; Warren, 2005), criminal activity (Allen, McSeveney & Bankston, 1981; Bankston, St. Pierre & Allen, 1985; Huff-Corzine, Corzine & Moore, 1986) and even extend to the physiological responses of individuals when provoked (Cohen, Nisbett, Bowdle & Schwarz, 1996). A strong influencer of personal values and behavior like southern culture was deemed worthy of investigation.

The local culture of the service area of the college is a distinct subset of southern culture (Gillin & Murphy, 1951; Hayes & Lee, 2005; Heath, 1983). That such subcultures exist within southern culture is widely documented and accepted (Bankston, St. Pierre & Allen, 1985; Burrison, 2003; Gillin & Murphy, 1951; Goldfield, 1981; Hayes & Lee, 2005; Heath, 1983). The southern subculture which dominates the area the college serves was investigated and documented by Shirley Brice Heath in her ethnography of the Carolina Piedmont published in 1983. Residence in the county serviced by the college, information available in college employee records, was chosen to represent familiarity with the particulars and peculiarities of the local culture and was investigated.

The impact of many experiential characteristics of faculty has also been investigated. For the purposes of this discussion these are divided into three subcategories, experience with secondary education, educational background, and college teaching experience.

The literature regarding influences on faculty has identified the academic discipline of specialization as having a strong impact on faculty (Gao, 2000; Schwarze, 1996; Skirvin, 1998). Stark, in a large study of faculty published in 1990, stated that “influences on course planning vary substantially by teaching field” (Abstract). Subsequent research has supported this finding. Einarson’s dissertation reports academic discipline to be a significant influence on all aspects of “faculty role behavior” (2001, p. 2). This includes factors like teaching goals selected (Fox, 1997), content inclusion (Helton, 2000), use of digital learning management platforms (Martin, 2003), and approach taken in relating to students (Ngabung, 2002). The influence of academic discipline also extends to the perceptions and attitudes of faculty members. Seidman found it influenced faculty conception of the construct critical thinking (2004). Huang’s study found it associated with faculty perceptions of the efficacy of instructional technology (2001). Adam found the influence to extend to faculty understanding of the methods and motives of college administrators (2004). The strong and extensive influence of academic discipline of specialization on faculty was important to the present study in regard to the independent variables classified as experiential and which represent educational background.

The influence of academic discipline of specialization is important to the study as there are two major areas of academic specialization possible for the developmental

mathematics faculty. These are Mathematics and Education. As noted in the previous paragraph, each of these areas of specialization can impact “faculty role behavior” (Einarson, 2001, p. 2) in different ways (Stark, 1990). Therefore, each of these variables was investigated in the present study.

That academic background in Education should be a separate category of independent variables is supported by the work of McDougall (1997) and Dobbs (2000) in respect to higher education faculty and by various investigations related to teachers in secondary education. Both McDougall and Dobbs found that training received by faculty impacts their instructional decisions and behavior. McDougall’s research found a lack of background in measurements and assessment on the part of higher education faculty was associated with a failure to use sound testing practices (1997). Dobbs found training impacts higher education faculty practices associated with distance education (2000). Investigations of secondary educators reveal that a background in Education (Kon, 1994) and years of experience in secondary education (Reed, 1994) are associated with teacher practices. A review of research regarding influences on teachers in secondary education conducted by Moore revealed the pervasive association of a background in Education and experience in secondary education on “teacher cognition and practice” (1999, p. i). Authors in developmental mathematics literature have also made this assertion (Garcia, 2003). In addition, the literature cited above supporting the belief that an experienced or educated person can communicate to another person knowledge, skills and attributes based upon the experience or education of the first party and thereby alter cognitive or non-cognitive outcomes for the second party lends support to the influence of educational background.

A background in the academic discipline Education and teaching experience in secondary education have been shown to impact instructional activity on the part of instructors in higher education and secondary education. In response to this information, a number of independent variables were developed for this study. These sought to categorize different aspects of a background in the academic discipline Education. An attempt was also made to separate the possible influence of experience in secondary education from that of an academic background in Education.

Teaching experience is a variable commonly considered in the literature, in respect to higher education (Peters, 1996; Fox, 1997; Hargrove, 2000; Einarson, 2001; La Nasa 2001) and secondary education (Kon, 1994; Reed, 1994; Moore, 1999). However, the author is not aware of a study that has investigated concurrent activity in secondary and higher education. As research support existed for the significance of the independent variables related to instructional experience in secondary education and there was an opportunity to initiate information gathering in relation to the impact of concurrent involvement in secondary and college instruction, both variables were included as independent variables.

Two independent variables were identified for the study as potentially significant in respect to the influence of an academic background in Education. The first was possession of a bachelor's degree in Education. While allowance was made for separating degrees completed in elementary and secondary education (middle school degrees were classified as secondary education) none of the faculty in the study had completed an undergraduate degree in elementary education. As a result, the category undergraduate degree in Education became undergraduate degree in secondary education.

In the study, a bachelor's degree in Education was considered indicative of an entry level background in the academic discipline of Education as it requires completion of a prerequisite number of undergraduate courses in Education. The second variable representing a background in the academic discipline Education was an advanced degree in Education (i.e. M.S. Mathematics Education, Ed. D.). Possessing an advanced degree in Education was considered indicative of study in the field of Education beyond the entry level. Both of these variables were included based upon the strong evidence for the impact of academic discipline of specialization described above.

Two independent variables were included to address the impact of academic work in the field of Mathematics. These were hours of graduate study in mathematics, and predominant type of mathematics studied. Hours of graduate study was employed as a means of segregating levels of achievement within higher education beyond an undergraduate degree. Lei's work found this variable, as associated with academic titles (i.e. master, doctor), to be an influencer of higher education faculty (2003) as did Einarson in respect to use of active learning strategies (2001) and La Nasa in respect to time devoted to teaching (2001). Hathaway found it associated with student outcomes following mathematics remediation in secondary education (1983). Predominant type of mathematics studied in graduate school was also investigated by Hathaway in respect to student outcomes in secondary education in North Carolina (1983) and the present study sought to extend this concept to a community college setting. With the support of the literature the number of hours of graduate study by faculty members in mathematics and the predominant type of mathematics studied were included as variables, possible influences on student outcomes, for investigation in this study.

Two independent variables were identified for the study in respect to the potential influence of having experience providing instruction at the college level. These were instructional experience at the college which served as the site of the study and cumulative college teaching experience. Two variables were postulated as the second is the superset of the first. The first includes teaching experience at one college. The second, the superset, considers all college teaching experience. Separating the two allows for consideration of the impact of experience as a faculty person within a local context and consideration of the impact of experience as a faculty person at large. The research literature supports the significance of these factors.

Teaching experience in higher education has been shown to impact faculty decision making and practice and was postulated in the study being described to impact student outcomes. Fox found that the number of years of teaching experience was associated with the selection of teaching goals (1997). Peters found in 1996 that higher education teaching experience impacted the frequency and extent of curriculum change faculty conducted. Einarson's work in 2001 found an association between teaching experience and the use of active learning strategies. La Nasa reported that teaching experience and time devoted to teaching were positively associated (2001). Teaching experience in higher education has even been shown to be correlated with integration of technology in instruction (Hargrove, 2000). And, Davis reported that three of four developmental educators believed that faculty instructional experience was related to and important for student success (1999). Each of these studies supports the significance of investigating teaching experience in higher education in respect to student outcomes in developmental mathematics. The two variables identified allowed for possible

distinctions to be observed between the impact of general college teaching experience and the impact of college teaching experience gained and applied within one setting.

Academic rank is a variable related to teaching experience but often treated as a separate topic in research in higher education. In 1992, Colbeck found, using data from a survey of 5,450 faculty at 306 institutions, that achieving a rank that includes tenure was believed by faculty to be the most influential factor related to their interest in teaching and research. Bullard's 1998 study found faculty rank to be one of three variables that impacted faculty instructional practice among faculty in teacher education programs in Georgia although Mathew's 2001 study at Oklahoma State University found that faculty rank was independent of faculty attitude toward computer based instruction. Yet in 2000, Hargrove had results similar to those of Bullard when considering similar relationships at Middle Tennessee State University. The difference in the results between the studies of Bullard and Hargrove and Mathew may be accounted for by variation in the instruments used to gather the data. The least that can be said is that faculty rank is believed by faculty to influence their actions in teaching and research and has been shown to influence faculty behavior in a number of studies at several four year institutions but that data is lacking for two year institutions. Many community colleges do not have faculty rank systems. The presence of faculty rank at the institution which served as the research site provides the opportunity to investigate this construct and its association with student outcomes in developmental mathematics.

The information gathered about the educational background of faculty facilitated the inclusion of one additional variable, possession of a degree from a community college. The researcher was unable to find studies which included the potential impact of

faculty having studied at a community college on the outcomes of the students they teach. However, one would expect that experience as a student in a community college would aid a faculty person in planning for the education of community college students and the work of Hagedorn, Perrakis and Maxwell (2002) Cejda and Rhodes (2004), Elliot (1989), Woerner (1993) and Grosset (1997) cited above can be used to support this. In addition, Leidig's 1996 survey of Miami Dade Community College (MDCC) faculty can be taken as indirect evidence of the potential impact of these variables. MDCC faculty identified their past instructors as influences on their instructional practices (Leidig, 1996). While to the best of the author's knowledge there is no direct evidence in the literature of higher education regarding a connection between a faculty person's alma mater and the outcomes experienced by that faculty person's students these variables were included in the study as potential influences.

The research chronicled in the literature of higher education related to influences on higher education faculty supports the significance of the independent variables selected for this investigation. A number of published studies regarding teachers in secondary education also support the potential impact of variables selected for the present study. In addition, attention given to some of these variables in the literature considering influences on faculty and student outcomes in developmental mathematics supports the significance of these variables for the study and provides a standard for comparison of results.

Several potential independent variables could not be investigated in the setting chosen for this study. The independent variable instructor's race could not be investigated as all the faculty persons in the mathematics division at the college are White. Racial

background is advanced by Milner and Ford (2005) as a strong influencer of instructor classroom practices. Helton's investigation in 2000 is also evidence of this. However, this study considered historic data at one institution. The uniform racial composition of the mathematics faculty prevented the inclusion of race as an independent variable.

In addition to the racial background of the instructor, another potential independent variable could not be investigated. In the research setting, it was not possible to separate years of teaching experience at the college and years of experience teaching developmental mathematics at the college. Since developmental mathematics was introduced into the curriculum at the college it has been Math and Science division policy to have all mathematics instructors teach both developmental mathematics and curricular mathematics. As a result, the cumulative years of teaching experience at the college is also the number of years of experience an instructor has teaching developmental mathematics at the college. While this circumstance prevents investigation of one possible independent variable, it expands the potential of another.

There are faculty persons at the college who have taught mathematics at the institution for 20 years, 25 years, and even 35 years. These individuals have several decades or more of teaching experience in developmental mathematics. The opportunity to investigate the impact of such extended tenure in this field is rare. In 2002 Stahl wrote the following regarding developmental education, "For so many of our programs, it has been less than a generation since they were birthed, and for so many of our colleagues, it has been less than a decade since they began their service to the profession" (p. 3). The research setting included the opportunity to investigate the impact of extended experience teaching developmental mathematics on student outcomes. This was a potentially

significant extension of the understanding of factors which impact student success rates in developmental mathematics.

The type of graduate school attended by faculty members, public or private, was not included as a variable even though this information is available in personnel files. There was insufficient variety in the academic background of the college's mathematics faculty to facilitate such a comparison. Only one faculty person attended a private institution for graduate study and that individual taught only one semester during the period of the study.

The faculty characteristics investigated as independent variables have drawn attention in respect to their influence on faculty in the general literature of higher education and to a far more limited extent in literature of developmental mathematics (Penny & White, 1998; Wheland, Konet & Butler, 2003). These studies provide background for the present investigation and support the importance of the independent variables chosen. In addition, the fact that developmental mathematics is a relatively new research field and the impact of the proposed variables on student success in developmental mathematics at a community college has not been thoroughly investigated adds to the significance of the present study.

While the pragmatic practitioner focused literature of developmental mathematics includes very limited attention concerning the influence of faculty characteristics on student outcomes, the significance of developmental education and opportunities it presents for research has not been lost on doctoral students. A number of dissertations have addressed the characteristics of faculty in developmental education and their impact on student outcomes.

Related dissertations

A limited number of dissertation studies have addressed characteristics of faculty in developmental mathematics. Only some of these have investigated the association of faculty characteristics and student outcomes. All such studies found by this author are described below.

Nine dissertations were completed between 1994 and 2006 which considered developmental mathematics faculty and student outcomes. In 1994, Barker described the impact of the faculty use of calculators, manipulatives, and programmed instructional support on student outcomes in developmental mathematics. In 1996, Klein compared instructor perceptions of their own teaching efficacy with student outcomes while Penny included a comparison of faculty employment status with student outcomes in her investigation in developmental mathematics. Gross completed a dissertation considering faculty attitude toward teaching developmental mathematics and student outcomes in 1999. Hewitt completed a dissertation in 2001 regarding the impact of faculty employment status on student outcomes in developmental mathematics. In 2002, Simpson, Christian and Bedard completed a collaborative Action Research dissertation at the University of California at Los Angeles (Simpson). The first third of this project, completed with Simpson as the primary investigator, established a data set and the data analysis upon which the remainder of the project was based. This data set included quantitative and qualitative information about faculty teaching developmental education (Simpson, 2002). Fike's 2005 dissertation described the impact of class schedule and instructor employment status on student outcomes in developmental mathematics. Morris investigated the "attitudes held by developmental mathematics instructors in Texas

community colleges toward developmental mathematics programs and students and the extent of the effect these attitudes have on student success” (2004, p. 1) in the same year. And in 2006, Smith surveyed community college developmental mathematics instructors and mathematics department chairs in the state of Tennessee regarding the use of calculators in developmental mathematics. Her results included a description of the typical developmental mathematics instructor in the state of Tennessee. While none of these studies sought to consider a broad range of faculty characteristics and their possible impact on student outcomes in developmental mathematics, the research done by Barker, Klein, Penny, Gross, Hewitt, Simpson, Christian, Bedard, Fike, Morris and Smith is related to the present investigation and will be discussed below. The studies will be addressed in order of similarity to the present investigation beginning with those with general similarities and proceeding to those which investigated some of the same characteristics of faculty as the present study.

Barker’s research addressed the impact of a limited number of faculty characteristics and practices on non-traditional aged students in developmental mathematics at Oklahoma City Community College. These included individual meetings with students and the “use of calculators, manipulatives, and programmed instructional materials” (Barker, 1994, p. 93). The factors investigated were found to be “related to higher academic achievement” (Barker, 1994, p. 93) by non-traditional age students while “traditional instruction was not found to be related to academic achievement” (Barker, 1994, p. 93). While Barker’s investigation focused on the instructional activities of faculty, which is not the focus of this investigation, it did establish a link between faculty traits and actions and student outcomes in developmental mathematics.

In respect to the present study, the work of Klein is similar to that of Barker. It did not directly address a faculty characteristic found in this study. However, it did consider a personal trait of faculty and its impact on student outcomes in developmental mathematics. Klein found “teacher efficacy had a significant negative relationship with student achievement” (1996, p. 75). This is important for the present study as a demonstration of statistically significant relationship between a non-instructional faculty trait and student outcomes.

In 1999, Gross researched the attitude of faculty toward teaching in developmental education in the 11 four year institutions in the state of Maryland. She compared attitudinal measures from 226 faculty based upon the instructor’s history with developmental education, having taught or not taught these courses, level of training in academic remediation, teaching experience, area of academic specialization, academic rank, gender, age, and tenure status (1999). Her findings include the following: faculty with more than 16 years of teaching experience believed there are too many low ability students are present in higher education (Gross, 1999, p. 97); mathematics faculty had less positive attitudes about developmental education than faculty in other disciplines (Gross, 1999, p. 97); there was no significant difference between attitudes held by faculty with training in remediation and those without (Gross, 1999, p. 98); female faculty members were more positive about developmental education than males (Gross, 1999, p. 99); faculty in the age groups 40-49 and over 60 were more positive about developmental education than other faculty (Gross, 1999, p. 99); non-tenured faculty are more positive about developmental education than tenured faculty (Gross, 1999, p. 100); and, overall attitudes toward developmental education among faculty tended to be negative (Gross,

1999, p. 100). This research is significant for the present study for the following reasons. First, it demonstrated variation in faculty attitudes associated with personal and experiential characteristics. Second, it established that there were differences in attitude, a faculty trait, specific to faculty teaching developmental mathematics.

The data set gathered and analyzed by Simpson (2002) for the collaborative dissertation of Simpson, Christian and Bedard is related to the present study in the same manner as the work of Gross (1999) but adds an additional element. It demonstrated variation in faculty attitudes and practices associated with personal and experiential characteristics. It established that there were differences specific to faculty teaching developmental mathematics. And, it established that a number of these faculty characteristics were associated with increased student success. An online questionnaire employed which consisted of “71 questions; 31...dealing with the background of faculty and their teaching practices” (Simpson, 2002, p. 73) yielded five similarities between faculty who are associated with high student success rates in developmental studies. These similarities for faculty with high student success rates, drawn from responses to “closed and open-ended questions” (Simpson, 2002, p. 73), were: the faculty members did not interact socially with students (Simpson, 2002, p. 98); the faculty reported providing a “structured classroom environment which kept students on task during the class session and on track for the whole semester” (Simpson, 2002, p. 99); the faculty members felt “supporting students emotionally and academically was critical when working with developmental students” especially when working with students with “low study skills” (Simpson, 2002, p. 99); the faculty members were “less involved with workshops and conferences” (Simpson, 2002, p. 100) than their peers; and, “the math

faculty indicated that motivating developmental students was the biggest challenge” (Simpson, 2002, p. 100). While these results were not expressed in operational language and are therefore not easily applied to other settings, they provide background information for the interpretation of results in the present study.

Smith’s research also describes faculty teaching developmental education. It resulted in the development of a caricature of the average developmental mathematics faculty person in the state of Tennessee (2006).

“If an instructor were depicted as having all the traits of the majority of the participants’ responses, the following would be the Tennessee community college developmental mathematics instructor. This instructor would be a female Associate Professor (fully promoted) with a Masters Degree. She would have been a full-time college faculty member for 15 years or less and would have been teaching mathematics 16 or more years. She would have had 20 or less contact hours of professional development with graphics calculators and she would use a Texas Instruments graphics calculator in the classroom 0% to 20% of the time” (Smith, 2006, p. vii).

This information is important to the present study in considering the degree to which the results can be generalized as it describes the predominant characteristics of developmental mathematics instructors in the state of Tennessee.

Morris’ 2004 dissertation bridges the work of Gross (1999) and that of researchers considering personal and experiential characteristics of faculty such as Penny (1996), Hewitt (2001) and Fike (2005). Morris’ 2004 dissertation describes the attitudes of Texas developmental mathematics faculty toward both developmental mathematics programs

and students “and the extent of the effect these attitudes have on student success” (p. 65). The faculty characteristics Morris sought to relate to faculty attitude were: “full- or part-time status, number of years of teaching experience, educational level (bachelor's, master's, or doctorate), educational major (mathematics, mathematics education, or other), amount of preparation for teaching, and amount of preparation specific to developmental education” (2004, p. 95). The attitudinal survey revealed that the faculty had a positive attitude regarding developmental studies and developmental students including a belief that developmental programs are important and should be perpetuated (Morris, 2004). Faculty felt teaching developmental mathematics was a valuable activity and that most students can succeed in this area given interest and effort (Morris, 2004). “The study found no significant difference in the instructors' attitude scores based on full- or part-time status, years of teaching experience, educational level, educational major, or amount of preparation specific to teaching” (Morris, 2004, p.92). Another result was “a small, but statistically significant, correlation was found between attitude scores and student success rates” (Morris, 2004, p. 92). These findings can aid in the interpretation of the results of the present study.

Penny's work in 1996 is the first in this group of dissertations to directly address personal traits and experiential characteristics of faculty and their impact on student outcomes. The faculty characteristics investigated in her study were gender, age, educational preparation, experience, and employment status (Penny, 1996). The investigation was conducted at three universities in a southern state. She found that male instructors had a negative effect on outcomes in developmental mathematics (Penny, 1996, p. 67). She found that part time employment status positively related to student

outcome in the highest level of developmental mathematics offered at the college (Penny, 1996, p. 68). All other faculty characteristics investigated, age, educational preparation and instructional experience, were found to have no significant impact on student developmental mathematics outcomes in the highest level course offered (Penny, 1996). This information relates directly to the present study as gender, age, educational preparation, instructional experience, and employment status were considered in respect to impact on student outcomes at each of three levels of developmental mathematics.

Hewitt (2001) also documented associations between faculty characteristics and student outcomes in developmental mathematics. Ms. Hewitt found that part-time and female instructors awarded significantly higher proportions of passing grades when compared with full time and male instructors (2001). In addition to passing grades in developmental mathematics the other indicators of student success in her study were “passing rates of post-developmental college-level mathematics students” and persistence at the college (2001, p. v). Developmental mathematics instructor employment status and gender were found to have no impact on these measures of success. This information relates directly to the present study as female and part time faculty, classified as a personal and an experiential characteristic in this study, were investigated.

Fike’s 2005 research included faculty employment status and class schedule as independent variables. The measure of student success was final grade in developmental mathematics. This study found that the number of students completing the course and the final grades of the students did not have a statistically significant association with faculty employment status (Fike, 2005, pp. 95-96, 99). However, when employment status was combined with the class schedule there was as significant association with student final

grade (Fike, 2005, p. 100). This is further evidence of the potential impact of the personal traits and experiential characteristics of faculty on student outcomes in developmental mathematics and material which can aid in interpreting results of the present study.

The dissertations written considering the relationship of personal traits and experiential characteristics of faculty to student outcomes in developmental education are few in number. None of the studies considered the impact of a broad range of faculty characteristics in respect to student outcomes. None of the studies were conducted with a large cross section of students at all levels of developmental mathematics. However, they have demonstrated relationships between some faculty characteristics and student outcomes, have demonstrated the validity of applying the Astin model for investigating faculty characteristics as environmental factors which impact student outcomes and have demonstrated the manifestation this impact had in a number of settings.

Summary

The present study advances knowledge in the field of developmental mathematics and developmental education by addressing the impact of faculty characteristics on student outcomes. While it addressed several factors investigated in other settings, it considered a much broader range of faculty characteristics than prior studies, considered them at a rural community college, a setting not previously included in the literature regarding the impact of faculty characteristics on student outcomes in developmental education, and investigated the impact on student groups sorted by entry level skill in mathematics.

Each of the independent variables investigated has support in the literature. The support available in the literature of developmental mathematics is very limited. The

other literature in the field of developmental education contains no additional supporting material. However, the literature of higher education includes studies considering all but two of the 15 variables investigated. While this information will be of limited value for interpreting the results of a study in developmental mathematics, it does demonstrate relationships between faculty characteristics and student outcomes and the validity of applying the Astin model for investigating faculty characteristics as environmental factors which impact student outcomes. Further, it indicates the manifestation this impact had in a variety of settings as well as the extent of that manifestation.

Data was gathered regarding each of the independent variables listed above. The compiled data set and the comparisons to student outcomes in the classes taught by the instructors are described in the final two chapters of this work.

CHAPTER 3 - METHODOLOGY

Objectives of the Study

This dissertation addresses a concern common to all regions of the United States, all institutions of higher education, and to the future of the American work force, student success rates in developmental mathematics. The research problem can be stated in the following manner: The purpose of this ex post facto study was to investigate the association of selected personal traits and experiential characteristics of faculty with student success rate in developmental mathematics at a rural North Carolina community college (Creswell, 1994, p. 64).

Research Design

The investigation was strictly quantitative. No qualitative elements were included. The research model employed was Alexander Astin's model for higher education research (1968; 1976; 1991). This model was enacted at a rural community college in North Carolina. Statistical analysis was performed with Microsoft Excel software.

Research Type

The investigation involves a retrospective and longitudinal consideration of data from the fall semester of 2003 through the spring semester of 2007 in a causal-comparative or ex post facto manner (Ary, Jacobs, Razavieh, & Sorensen, 2006, p. 632).

Research Methods

Theoretical Basis

The theoretical basis for the research was provided by the work of Alexander Astin who developed the Input-Environment-Output (I-E-O) model for higher education

research (1968; 1976; 1991). “The I-E-O model was developed...to study naturally occurring variations in environmental conditions and to approximate the methodological benefits of true experiments by means of...statistical analyses” (Astin, 1991, p. 28). In Astin’s model, an input is potential “for growth and learning that students bring with them to college” (1976, p. 11) or “personal qualities the student brings...to the educational program” (1991, p. 18). Students who are required to take developmental mathematics have arrived at the institution with a measured “level of talent...previously developed” (Zhao, 1999, p. 4), an input. An output in this model is “those aspects of the student’s development that the college either attempts to or does influence” (Astin, 1976, p. 11). Outcome is used as an alternative to the term output (Astin, 1976; 1991).

The investigation being described considered the association between the personal traits and experiential characteristics of faculty and student outcomes in developmental mathematics. The personal and experiential background of faculty are environmental factors in Astin’s model given the “definition of an environmental stimulus as follows: *any behavior, event or other observable characteristic of the institution capable of changing the student’s sensory input, the existence or occurrence of which can be confirmed by independent observation*” (1968, p. 5). Therefore, the research plan was a direct application of the Astin model considering a specific set of environmental factors.

Astin’s model shows particular concern for limiting the influence of confounding variables. The study was designed to “adjust for...input differences in order to get a less biased estimate of the comparative effects of different environment [factors] on outputs” (Astin, 1991, p. 19). “Unless the effects can be accounted for by identifiable institutional

characteristics, we cannot arrive at the generalizations needed for improving educational theory and for formulating sound educational policy” (Astin, 1968, p. 2).

All students participating in classroom based developmental mathematics courses taught by the mathematics department between fall of 2003 and spring of 2007 were included in the study, a purposive sample (Ary, Jacobs, Razavieh & Sorensen, 2006). This sample was divided into three groups based upon standardized testing scores. These groups correspond to the three developmental mathematics courses taught at the college. The particulars of the sorting of the applicants by mathematical skill level are provided in the discussion of the sample below.

The three levels of mathematical skill introduced into the sample by the standardized testing requirements and the corresponding courses stratify the sample by demonstrated mathematical skill level. Treating each skill level as a separate entity in data analysis controlled for diversity in the input characteristic considered, mathematical skill. The “fixed or invariant characteristics” (Astin, 1991, p. 70) of the student population, also input in the Astin model, were controlled by the inclusive nature of and the size of the sample. Since all students participating in developmental mathematics across a four year period were part of the sample, 3,918 students, no segment of the population of students under-prepared for curricular level mathematics at the college was excluded and no segment could have an influence out of proportion to its representation in the college’s developmental mathematics courses.

The study conducted was a direct application of the Astin research model. It employed a large purposive sample and considered a within-institution environmental factor, selected personal traits and experiential characteristics of faculty.

Site and Means of Access

The project was conducted at a rural community college in north-central North Carolina. It is the only institution of higher education in a rural county (Mueller, Slifkin, Shambaugh-Miller, & Randolph, 2004) with a population of 92, 614 (US Census Bureau, 2006). The college is situated in the small town which is the county seat. These characteristics mean the site corresponds to 33% (Phillippe & Sullivan, 2005, p. 8) of the 1,158 community colleges in the United States (Phillippe & Sullivan, 2005, p. 8). The county this rural community college serves has a distinct character which has been stable for an extended period of time.

The population of the county is approximately 80% White and 20% African-American (US Census Bureau, 2006). 68% of the persons age 25 or older graduated from high school, 10% below the state average high school graduation rate (US Census Bureau, 2006). Only 11% of the persons age 25 or older have a college degree, one half of the state average (US Census Bureau, 2006). These characteristics of the population have been stable for an extended period of time (US Census Bureau, 2006). The movement of persons into or out of the county is more than 10 points below the average for the state (US Census Bureau, 2006). And, the income level is low, 85% and 87% respectively when compared to the per capita and median income figures for the state (US Census Bureau, 2006). In addition to a historically low per capita income, the county experienced closures of many of its major employers in textiles and tobacco processing over the last decade. The county serviced by the college is characterized by lower than average level of education, a low college completion rate, a population that is not mobile, and which has below average income.

The demographics of the college's student population mirror the county population. For the last 16 years, 97% to 98% of the students at the college have been drawn from the county in which the college is located or adjacent counties (RCC, 2006d). The result is a population very representative of the county in racial composition, employment status, and family background in higher education.

Table 3.1

New student enrollment at the college by ethnic group 2003 to 2007

	Fall of 2003	Fall of 2004	Fall of 2005	Fall of 2006
White	76.6%	74.1%	77.5%	78.4%
African American	20.2%	22.7%	19.1%	17.5%
Native American	0.4%	0.3%	0.4%	0.4%
Hispanic	0.7%	1.0%	1.3%	1.4%
Asian	0.6%	0.5%	0.7%	0.9%
Other	1.5%	1.3%	1.1%	1.3%

(RCC, 2004; RCC, 2006a)

The college's student population, as represented on Table 3.1 shows limited variation between and within ethnic groups year to year. The same is true of part time student enrollment. 51.3% of students in 2003 (RCC, 2004), 52.7% of students in 2004 (RCC, 2004), 52.5% of students in 2005 (RCC, 2006a) and 51.7% of students in 2006 (RCC, 2006a) attended the college part time. Student employment status for the study period is portrayed on Table 3.2. It was also a characteristic that was stable in the student population in the period of the study. When compared with the average employment figures for community college students across the United States one sees that the college's students are less likely than average to be employed full time, they approximate the national average for part time employment, and are twice as likely to be unemployed (Phillippe & Sullivan, 2005). The employment status of the college's students reflects the economic characteristics of the county served as described above.

Table 3.2

Employment status of the college's students 2003 to 2007

	National Average	Research site averages			
		Fall of 2003	Fall of 2004	Fall of 2005	Fall of 2006
Full time	41.6%	21.9%	20.5%	21.9%	22.6%
Part time	38.4%	36.7%	34.0%	32.0%	32.1%
Unemployed	20.0%	39.1%	45.6%	46.1%	45.4%

(Phillippe & Sullivan, 2005, p. 50; RCC, 2004; RCC, 2006a)

In the fall of 2004, 88.7% of first term students came from homes in which both parents had a highest completed education level of less than a bachelor's degree (RCC, n.d.). This, like the other statistics above, replicates the county statistics. In this case, it mirrors the county wide college graduate rate of 11% of the population (US Census Bureau, 2006).

In addition to mirroring the county population in racial composition, employment, and low education attainment in their families, the student population has been very stable in the years investigated. Fall 2003 enrollment at the college was 2068 students (RCC, 2004), fall 2004 enrollment was 2188 students (RCC, 2004), fall 2005 enrollment was 2047 (RCC, 2006a), and fall 2006 enrollment was 2083 (RCC, 2006a).

The proportion of females to males among new students was 56.5% to 43.5% in fall of 2003 (RCC, 2004), 56.0% to 44.0% in fall of 2004 (RCC, 2004), 54.3% to 45.7% in the fall of 2005 (RCC, 2006a) and 52.4% to 47.6% in the fall of 2006 (RCC, 2006a). This characteristic parallels the national averages for community colleges of between 53.6 % to 55.6% of students being females between 1993 and 2002 (Phillippe & Sullivan, 2005, pp. 28-30). Students range in age from 16 year old dual enrollment or Huskins enrollment students to adults over the age of 65 (RCCa; RCC, 2006b; RCC, 2006c) with a mean age of 27.7 years in fall of 2005 (RCC, 2006b) and 28 years in fall of 2006 (RCC, 2006c).

These statistics and those in the previous paragraph illustrate that the student population in the school years 2003-2004 through 2006-2007 were similar. The overall enrollment, ethnic make up, student age distribution, proportion of female to male students, student enrollment status, student employment status, and highest education

attainment by the parent of students were consistent. As a result, there was little or no variation in the general characteristics of the sample during the period of study. They also indicate that the results of the study have the potential to be generalized to other community colleges. 49% of the 1,158 community colleges in USA are the same size or smaller than the college at which the research was conducted (Phillippe & Sullivan, 2005, p. 16) and 33% are in a rural setting or a small town (Phillippe & Sullivan, 2005, p. 18). The female to male ratio matches that of community colleges in general as does the enrollment status of students and the age range of students. In addition, the local nature of the student population is the norm among community colleges (Phillippe & Sullivan, 2005, p. 60).

The college which served as the research site is one of 58 in the NCCCS. It has a president who is responsible to the system president. The primary organizational structure is reflected in the areas of responsibility for the vice presidents. These are administrative services, student development, and instruction. There are six divisions headed by deans who report to the vice president of instruction. These are Business Technology, Continuing and Workforce Education, Health Sciences, Humanities and Social Sciences, Industrial Technology and Math and Science. The developmental education courses taught at the institution are resident in three of the divisions. The Humanities and Social Sciences division offers all the developmental English and reading courses. The Industrial Technologies division integrated developmental mathematics into its course offerings. The Math and Science division offers all the developmental mathematics courses taught to students who are not enrolled in Industrial Technology programs. It is the faculty of the Math and Science division and the students who took courses from

them in classroom based instruction in the fall of 2003 through the spring of 2007 that were considered in this project.

During the period of the study, the faculty of the Math and Science division had nine full time and 15 part time faculty members. In percentages, 37.5% of the faculty were full time and 62.5% were part time. The American Association of Community Colleges reported in 1995 that 65% of community college faculty worked part time (American Association of Community Colleges, 1995, p. 6). As noted in the previous chapter, this figure varies from college to college, from system to system and across time but does not appear to be declining. Phillippe and Sullivan reported that in 2001 the percentage of part time faculty in community colleges had risen to 66.8% (2005, p. 102).

Seven of the full time faculty and 13 of the part time faculty at the research site were females. Across the United States, community college faculty are split 51% female and 49% male (Phillippe & Sullivan, 2005, p. 102).

All of the developmental mathematics faculty at the college were White. In the community colleges of the United States 83% of the faculty, on average, are White (Phillippe & Sullivan, 2005, p. 106).

The age of the faculty members in the study as compared to the United States averages is presented in Table 3.3. The full time faculty at the college had a higher percentage of instructors under the age of 45 than is average in the United States community colleges and the part time faculty had more persons over 45 than is average in the United States community colleges.

The level of education among the developmental mathematics faculty is portrayed in Table 3.4. One full time faculty person had a doctorate, one had only an undergraduate

degree, the remaining seven had master's degrees. The part time faculty was split seven persons with a master's degree and eight persons with undergraduate degrees.

Table 3.3

United States community college faculty and the developmental mathematics faculty of the college: Age distribution comparison

Age	US % Full time	College % Full time	US % Part time	College % Part time
<35	6.5%	0.0%	12.1%	6.7%
35-44	21.9%	44.4%	25.8%	26.7%
45-54	41.2%	22.2%	37.3%	33.3%
55-64	27.1%	33.3%	18.2%	33.3%
65-69	2.2%	0.0%	4.3%	0.0%
70+	1.0%	0.0%	2.2%	0.0%

(Phillippe & Sullivan, 2005, p. 116)

Table 3.4

United States public community college Natural Science and Engineering faculty and the developmental mathematics faculty of the college: Highest level of education

Level of education	US % Full time	College % Full time	US % Part time	College % Part time
Doctorate	25.5%	11.1%	9.8%	0.0%
1 st professional	1.3%	0.0%	2.0%	0.0%
Master's	57.0%	77.7%	61.5%	46.7%
Bachelor's	12.9%	11.1%	19.2%	53.3%
Associate	2.9%	0.0%	4.6%	0.0%
Less than associate	0.4%	0.0%	2.9%	0.0%

(Phillippe & Sullivan, 2005, p. 118)

In regard to employment status, the college developmental mathematics faculty was representative of the general trend in American community colleges. However, the percentage of female instructors and the percentage of White instructors is higher than average, the age distribution is idiosyncratic, and the highest level of education is predominantly a master's degree among full time faculty and almost evenly split between undergraduate and master's degree among part time faculty. While one would not expect the college's developmental mathematics faculty to exactly represent the national averages, some of the local variations from the national averages are pronounced. However, having pronounced characteristics can provide an advantage in an investigation of this type. That the college faculty exhibit pronounced characteristics could lead to a clearer understanding of the impact of some of the personal traits and experiential characteristics of faculty on the outcomes of students in developmental mathematics.

The Math and Science division at the college has instituted a common curriculum in developmental mathematics. This includes all course material, all assessment, and instructional policy. All developmental mathematics courses use the same text which was designed by the publisher to include material for a multi-tiered set of developmental mathematics courses. Each course level has a common set of curriculum guidelines, quizzes, and exams which have been prepared in house by the college mathematics department. Course syllabi are crafted at the department level and instructional policies are set at the department level and enforced in all classrooms. This characteristic of the college, a common curriculum in developmental mathematics, makes it an ideal setting for an investigation of this type. Since the curriculum for each course is common to every classroom in which that course is being taught, the potential impact of an additional

independent variable which is not being investigated (Ary, Jacobs, Razavieh, & Sorensen, 2006, p. 278), individual curricular planning by instructors, was minimized.

The college scheduled and taught developmental mathematics as telecourses and as online courses during the period of the study. For the purpose of the investigation, these course sections were excluded. This decision was taken since changing the medium in which instruction is presented alters course curriculum, alters patterns of interaction with the instructor, and changes the areas and types of responsibilities borne by the student. Only developmental mathematics sections taught in traditional face-to-face classroom settings were included in the study.

Student success rates in developmental mathematics at the college were approximately 50% in the period under consideration. The average passing rate for MAT 060 Essential Mathematics (Rockingham Community College [RCC], 2007) for all sections included in the study was 57.93%. The average passing rate for MAT 070 Introductory Algebra (RCC, 2007) for all sections included in the study was 52.57%. The average passing rate for MAT 080 Intermediate Algebra (RCC, 2007) for all sections included in the study was 43.38%. While the reader might expect for the passing rate to be higher in lower levels of mathematics, that the passing rate at this level (the level with the highest passing rate), are so near a one to one ratio (random) indicates the significant challenges in developmental mathematics at the college.

Data for the study was obtained from college records. Access to computerized student records and other college records was negotiated by the researcher. A letter approving the use of the college information and records by the investigator for research and publication was drafted, signed and provided by the college President.

Instrumentation

All information required for the study was available in physical or computerized college records and college personnel files. No instrument was developed or employed to gather data for the study.

Sample

The study concerned the effect of faculty background and experience on student performance in developmental mathematics. To facilitate this investigation, records of the academic outcomes in developmental mathematics for all students enrolled in these courses at the institution between the fall semester of 2003 and the spring semester of 2007 were employed. Data from 100% of the students enrolled in classroom based developmental mathematics during this period were used in the project. Telecourses and online sections were excluded from the study. Students were considered enrolled if they registered for the course and did not drop it within the drop/add period prescribed by the college. As a result, the sample size was large. 3,918 students took classroom based developmental mathematics courses during the period of the study. The sample size allowed for homogeneous groupings of subjects to be formed when analyzing data as a control for the effects of intervening variables (Ary, Jacobs, Razavieh & Sorensen, 2006, p. 368; Astin, 1991; Creswell, 1994, p. 64). These groups were the three levels of developmental mathematics study.

All applicants to the college must demonstrate a given level of proficiency in mathematics to enter curricular mathematics. Proficiency can be demonstrated in a number of manners. An SAT mathematics score of 500 and ACT mathematics score of 21, transfer of curricular mathematics credits from another college, or a COMPASS test

Algebra score of 50 or above are accepted as evidence of mathematical proficiency (T. Kent, personal communication, November, 2007). The majority of applicants to the school did not have these credentials between fall of 2003 and spring of 2007 (Preuss, 2008a, 2008b; Stultz, 2006).

Applicants to the college who can not demonstrate mathematical proficiency with an SAT score, ACT score or transfer credit are required to take the COMPASS placement test. Applicants who did not test out of developmental mathematics by receiving an Algebra score of 50 or better are sorted into one of three levels of instruction based upon their placement test outcome. Algebra scores of 43 to 49 on the COMPASS placement test places the applicant in MAT 080 Intermediate Algebra (RCC, 2007), the highest level of developmental mathematics. Algebra scores below 43, Pre-Algebra scores between 42 and 99 or a combination of the two places the applicant in MAT 070 Introductory Algebra (RCC, 2007), the middle level of developmental mathematics. Pre-Algebra scores of 0 to 42 on the COMPASS test places the applicant in MAT 060 Essential Mathematics (RCC, 2007), the lowest level of developmental mathematics. These courses are part of a state wide common course catalog shared by the NCCCS and the North Carolina University System.

As demonstrated above, the characteristics of the student population remained stable during the period of the study. This included the need for developmental mathematics in the student population of the college which was 57.7% in fall of 2003, 58.1% in fall of 2004, 54.4% in fall of 2005, and 57.0% in fall of 2006 (Stultz, 2006). The result was a sample that was large, uniform and grouped by level of mathematical ability.

Data collection

The college had completed a digital conversion of its records from fall of 2005 forward prior to the study and these digital records were used to construct part of the data set. Spreadsheets of student outcomes compiled by the college to create reports for the NCCCS were used to gather the data set from the 2003-2004 and 2004-2005 school years. The digital records were archived on servers at the college. They were accessed through a program known as Colleague Information System (CIS). This program is employed by all the community colleges in the state of North Carolina for record keeping. The data from 2003-2004 and 2004-2005 in physical form was retrieved from the college Institutional Research and Planning Office secure file room. The researcher secured access to physical and digital records and written permission to employ the student information in this dissertation project. As a result, the information gathered about students had been previously verified for accuracy by the college student development personnel who maintain the college's student records.

There are three course levels of developmental mathematics taught at the college. The lowest level is MAT 060 Essential Mathematics (RCC, 2007). The middle level course is MAT 070 Introductory Algebra (RCC, 2007). The highest level of developmental mathematics is MAT 080 Intermediate Algebra (RCC, 2007). Data was gathered to allow analysis of the impact of faculty characteristics on student outcomes at each level of developmental mathematics.

Information gathered about students

The student outcomes in developmental mathematics were accessed from course grade reports. This information is available course section by course section on printed

spreadsheets for school years 2003-2004 and 2004-2005 and in CIS from fall of 2005 forward. Once accessed, the information was transferred to an Excel workbook. The workbook included multiple worksheets. The primary sort of the data set was by instructor, course, and section.

Within an Excel workbook a worksheet for each instructor who taught developmental mathematics in the period fall of 2003 to spring of 2007 was created. The student outcomes data was posted on these worksheets by course level and course section for each instructor. For example, one instructor might have taught MAT 060 and MAT 070 sections in a given semester while a second taught MAT 070 and MAT 080 sections. In this example, the first faculty member would have student outcome data from each section of MAT 060 and MAT 070 he or she taught in the semester entered on an instructor specific worksheet. The second instructor would have student outcome data for each section of MAT 070 and MAT 080 taught during the semester entered on a separate instructor specific worksheet.

The data captured on the worksheets was summaries of student outcomes by course section not results for individual students. The data captured was the total enrollment, drop, passing, failure and withdrawal figures for each course section. All students who dropped the course within the approved drop/add period during the semester were subtracted from the total enrollment for the course and not included in the statistical analysis for this study. Cumulative totals of student outcomes, by course level, were compiled for each instructor. These cumulative totals were included on the instructor specific worksheet. It was these cumulative totals of student outcomes across the period fall of 2003 to spring of 2007 which were employed in the data analysis.

Another worksheet was created to summarize the entire data set. The cumulative totals of student outcomes by instructor and course level were compiled by formulas imbedded in the Excel worksheets. These cumulative totals were transferred to a master worksheet on which a cumulative data set for all instructors was displayed. Imbedded formulas were employed to access the data from instructor specific worksheets and transfer it to the master worksheet. The master worksheet included additional imbedded formulas to calculate descriptive statistics from the cumulative totals of student outcomes.

Student outcomes, successful completion or non-completion, were measured on the basis of final course grade. This decision was made for a number of reasons. These were the universal acceptance of the proposed dependent variable in higher education, the use of final grades as evidence of student success in colleges and in research literature, the nature of the study, and the characteristics of community colleges in general as actualized in the study setting.

Employing Astin's descriptive terminology, the study is investigating the impact of given environmental factors on a short term or acute outcome (1976; 1991). This outcome is success in developmental mathematics at any of three levels in a given semester. Using final student grades as evidence of success or lack of success is an accepted pattern in higher education.

The standard measure of success in a course over a semester in higher education is a passing grade. This is taken as tangible evidence of learning and skill being developed to the expected level. This is the definition of success employed by the NCCCS in respect to courses in developmental education (NCCCS, 2006, p. 36). Final

grades as a measure of a student success in a given semester is also a universally accepted standard in higher education research.

Final grade is commonly employed as the standard of student success in research studies and dissertations which consider developmental education. It was the standard employed in each of the state system and institution specific studies conducted by the Florida State Board of Community Colleges (Fleishman, 1994), the Minnesota Community College System (Schoenecker, Bollman & Evens, 1996), the Maryland Higher Education Commission (Waycaster, 2001), Maricopa Community College District of Arizona (The Maricopa Community College District Institutional Effectiveness Office, 2000), Pierce Junior College in Philadelphia, Pennsylvania (Daughtry-Brian, Fox, & Wieland, 1993), Prince George Community College in Maryland (Seon & King, 1997), Bronx Community College (Finkelstein, 2002), Germanna Community College of Virginia (Curtis, 2002), and Rio Hondo Community College of California (Maack, 2002). It was also the standard employed in dissertations studying developmental mathematics or developmental education written at McNeese State University in 1981 (Yellott), Georgia State University in 1983 (Gordon), the University of Oklahoma in 1994 (Barker), Grambling State University in 1996 (Penny), West Virginia University in 1996 (Vavra), Montana State University in 2004 (Geller), and Touro University International in 2005 (Fike). Final grade is an accepted measure of student success in the research literature.

The study described was planned and conducted in an ex post facto manner. Measures of student success employed in the study must be information maintained in college records. The sole measure of student success in a one semester course maintained

by the college is course grade. In addition to this being an accepted measure in higher education, the use of historic data limited the study to this standard.

One might argue that success in subsequent mathematics courses would also be an indication of success in remediation and available in college records. Studies have been conducted which employed this definition (Ashburn, 2007; Campion, 1993; Davis, 1999; Schoenecker, Bollman & Evens, 1996; Seybert & Stoltz, 1992; Texas State Higher Education Coordinating Board, 2002). However, the data set employed in the study did not allow an investigation that included this variable. The physical records of student outcomes for school years 2003-2004 and 2004-2005 summarized the data for each course section. It did not include results for individual students. Without the ability to track the academic records of individual students it was not possible to include outcomes in subsequent mathematics courses as an indication of success. Even if the researcher had sought to include success in subsequent mathematics courses as a variable, the nature of many of the programs offered by community colleges and the divergent purposes of students in attending community colleges would render this variable unworkable.

Students in open enrollment community colleges may be without a program, taking a course locally to transfer to another institution, pursuing a six month certificate, working toward a one year diploma program, or seeking a two year degree. Many of the certificate and diploma programs offered require the student to test out of or to pass only one level of developmental mathematics. Degree programs require demonstration of sufficient skill to pass multiple or all levels of developmental mathematics. The specific requirements and pre-requisites are determined by the state college system and locally by faculty. This broad spectrum of purposes and pre-requisites means that many students

move in and out of the institution without taking multiple developmental courses in one discipline. This circumstance renders the use of subsequent success as a dependent variable untenable unless data is available for individual students who are part of a very large sample taken across an extended period of time. If attempted, a sample of many thousands of students would be required to allow representative groupings in each of the possible categories when considered instructor by instructor. The student volume in developmental mathematics at the site was not sufficient to support constructing a sample of this size with the records available and the records did not include identifiers of individual students. Considering success in subsequent course in the same academic discipline as a dependent variable was not possible with the data set available from the college.

It is for the reasons above that the dependent variable was limited to completion rate as determined by final course grade. It should be noted that this measure is not as one dimensional as it might appear. Course final grade is a cumulative summary of homework grades, lab grades, quiz grades, unit test grades, final exam grade, and assessment of participation. The final course grade is a multi-dimensional measure of student outcomes and, as demonstrated above, is commonly employed in scholarly works.

No data allowing identification of individual students was accessed for the purposes of the study.

Information gathered about faculty

The information required to categorize faculty characteristics identified as the independent variables in this study was obtained from college personnel files. As a result

of this method, the information about faculty which was employed in the study had been previously verified by an independent observer, the college personnel director. This information was entered in an Excel workbook prepared for this purpose. Instructor specific worksheets were labeled with numeric codes assigned to the instructors. A master list of instructor name and corresponding numeric identification was maintained as part of the Excel workbook. All faculty members active in developmental mathematics instruction on a full time or part time basis during the period fall of 2003 through spring of 2007 were included in the study.

In addition to demographic information and information regarding the instructor's educational background, colleges maintain records of student evaluations of instruction (SEI) and instructor performance evaluations conducted by Deans or other college personnel. Neither of these types of information was employed as independent variables or in the discussion of the results of the study. The reasoning behind this decision is provided in the following paragraphs.

Rankings received by instructors on SEI were not employed in the study. This decision was reached based upon the nature of SEI and practical concerns. SEI are suspect in terms of construct validity and, as a result, criterion validity. Simply stated, teaching effectiveness is a construct without a universally accepted definition (Hooper & Page, 1986; Olivares, 2003; Shevlin, Banyard, Davies & Griffiths, 2000). This is not an opinion isolated to critics of SEI. "Supporters and critics...concur that 'teacher effectiveness' has not been adequately defined and operationalised" (Olivares, 2003, p. 237) by educators and scholars. If a construct is not defined, one can not identify the criteria that make up this construct. As the construct validity of SEI is not established, the

criterion validity of SEI is suspect. SEI also exhibits “construct-irrelevant variance” (Linn & Gronlund, 2000, p. 83). That is, “performance [is] influenced by factors that are ancillary or irrelevant to the construct” (Linn & Gronlund, 2000, p. 83) for example the perceived sexiness of the instructor (Felton, Mitchell & Stinson, 2004). Finally, SEI are completed by parties who do not share a common understanding of teaching effectiveness. “There is considerable evidence that suggests that students do not hold a common view of teacher effectiveness (Chandler, 1978; McKeachie, 1979) and students are prone to judgmental biases (e.g. Scullen et al., 2000; Stanfel 1995)” (Olivares, 2003, p. 237).

“Students’ holistic rankings represented their own perceptions of quality teaching with no parameters set by a standardized evaluation instrument....students base their evaluations on an implicit personality theory of a good instructor....recall previous information and infer other information from their personality theory” (Obenchain, Abernathy & Weist, 2001, p. 4).

Olivares summarizes these arguments saying,

“given the quiddities of human nature, the nature of SRT’s [student ratings of teachers], and the method by which ratings are generated and instructor effectiveness evaluated, it is highly improbable that student ratings are good measures of teacher effectiveness. Furthermore, evidence by both supporters and critics of SRT’s, as well as the principles of validation and logic therein, suggest that SRT’s are of questionable validity and, therefore, are not appropriate for drawing inferences regarding ‘teacher effectiveness.’ Hence, the continued

resistance to SRT's as valid measures of teacher effectiveness appears to be well founded" (2003, p . 240).

Practical considerations also prevented the use of SEI's in this study. The mathematics department at the college has a highly insular closed culture. They have been very resistant to outside influence and do not permit non-departmental access to their meetings, decision making processes, or departmental records. Given this characteristic, an attempt to use mathematics department SEI's as part of the study would have been rebuffed by the department and perceived as a highly inflammatory request. This would have placed the completion of the dissertation project in jeopardy, a risk the researcher was not willing to take.

As a result of the nature of SEI and the cultural dynamics of the mathematics department at the college, SEI ratings were not employed in the study.

Performance evaluations completed by Deans and department chairs also were not employed. This decision was reached based upon the culture of the mathematics department described above, the turn over in leadership within that department during the period of study, the number of adjunct faculty employed at the college, and the researcher's personal experience with performance evaluation at the college. Attempting to arrange observations by non-department personnel in a mathematics classroom at the college is a politically charged undertaking. An attempt to access the performance review records of the mathematics faculty is a far more sensitive matter than a classroom observation. It would have resulted in strong objections which would have jeopardized the completion of the project. Even if the records were reasonably accessible, the reviews which would have been available were conducted by a minimum of three different people

during the period of the study. The use of these records would include inter-rater variability which could not be resolved. Further, community colleges employ many part time instructors. Over half of the active mathematics faculty members at the college were adjunct faculty. Supervisors of personnel at the college are not required to conduct performance reviews for part time employees. As a result, over half of the mathematics faculty would not have received a performance review. Finally, the researcher is an employee of another division at the college. He has not had a performance review in his three year term of employment at the college and he is aware of a significant number of other full time employees who have not had performance reviews for extended periods of time. Based upon this experience, it is a reasonable assumption that one or more of the full time mathematics faculty members would have gone without a performance review in the period considered in the study. Due to the politically charged nature of a request to access faculty performance reviews, the inter-rater variability that would exist in any reviews that have been completed, the large number of faculty to be included in the study who were part time and would not have received a review and the researcher's experience with inconsistency in execution of the review process at the college, faculty performance reviews were not included in the study.

The ex post facto investigation of the association of the personal traits and experiential characteristics of faculty with outcomes in developmental mathematics incorporated a large purposive sample. The purposive sample included grouping the participants by skill level in mathematics. Data gathered for consideration of the independent variables focused on characteristics which could be identified in personnel records and which did not include departmental or student evaluations of instructors.

Data Reduction and Coding

Dependent variable data

Student outcome data was recorded as numeric values on the Excel worksheets. This data was cumulative totals of students in the categories enrollment, drop, passing, failing, and withdrawal sorted by instructor, course type and course section or summations of these figures. All students who dropped the course within the drop/add period specified for the given semester were subtracted from the enrollment total for the course and not included in the statistical analysis for this study.

On the master worksheet described above, cumulative data for each level of instruction was sorted by instructor, summarized for all instructors by course type, and described using measures of central tendency. This information was employed in the statistical descriptions of the data and the statistical analysis.

In the analysis, student outcomes were classified in two categories. These are successful completers and unsuccessful students. Successful completers were all students achieving a grade of C or better. Unsuccessful students were all students receiving a D, an F, or withdrawing from the course. Students with D's were classified as non-completers following the paradigm of the NCCCS which requires a grade of C or better in developmental education for a student to be counted in college reporting of student success rates in a developmental studies courses (NCCCS, 2006, p. 36). Students withdrawing from the course were counted as non-completers. This classification was employed since they did not persist to the end of the course and many students withdraw from developmental mathematics courses at the college to avoid receiving a low final grade. This practice is encouraged by the mathematics department as students who

withdraw are not included in the student success formulas in accountability reporting required by the state (NCCCS, 2006, p. 36).

Independent variable data

In the data analysis, cumulative totals of student data spanning the period fall of 2003 through spring 2007 were compared to the independent variables instructor age, gender, employment status, residence in the county served by the college, experience in secondary education, present employment in secondary instruction, graduation from a community college, holding only a bachelor's degree, possessing an undergraduate degree in Education, possession of an advanced degree in Education, predominant type of mathematics studied in graduate school, hours of graduate study in mathematics, cumulative years of instructional experience in higher education, cumulative years of instructional experience at the college and academic rank. Instructor characteristics which could be represented as numeric data, like age, were. Instructor characteristics which are not commonly represented as numeric values were assigned numeric codes. The coding system employed for the independent variables is described below.

Age was defined as the instructor's age at his or her most recent birthday prior to the initiation of the investigation. The raw data was recorded as numeric values. For the purpose of data analysis, instructors were grouped by age. These groupings were < 35 years of age, 35 to 44 years of age, 45 to 54 years of age, and over 55 years of age.

A number of the independent variables were binomial (Sternstein, 1994, p. 46). For these variables, the codes of 1 and 2 were employed. Instructor gender, male or female, is one these variables. The codes assigned were 1 for males and 2 for females. Employment status was a second binomial independent variable. Full time instructor

status was assigned the symbol 1 and part time status the symbol 2. County residence was the third yes and no variable. Faculty resident in the county were coded with a 1 and those who did not reside in the county with a 2. Instructor experience in secondary education, a fourth yes or no variable, was also coded using the values 1 and 2. The symbol 1 represented secondary experience. The symbol 2 represented no secondary experience. Present employment in secondary education as the fifth binomial variable was also coded 1 or 2. Instructors who were not concurrently employed in secondary mathematics instruction and employed in mathematics instruction at the college were assigned the code of 1. Instructors who were concurrently active in secondary mathematics instruction and instruction at the college were assigned the code of 2. Graduation from a community college is the sixth binomial variable. Faculty who were community college graduates were coded 1. Those who did not graduate from a community college were coded 2. The seventh binomial variable, holding only bachelor's degree, was also coded 1. All faculty with advanced degrees were coded 2. This variable was a binomial variable as there were no faculty who held only an associate's degree. Possession of an undergraduate degree in Education was an eighth binomial variable. Having completed an undergraduate degree in Education was coded 1. All other undergraduate degrees were coded 2. The final binomial independent variable is possession of an advanced degree in Education. Possession of an advanced degree in Education was coded 1. Not having completed an advanced degree in Education was coded 2.

Hours of graduate study in mathematics was coded in four categories. The symbol 0 represented no graduate hours in mathematics. 1 represented one to 18 hours of

graduate study in mathematics. The symbol 2 represented 19 to 36 hours of graduate study in mathematics. The symbol 3 will represented 37 or more hours of graduate study.

The coding of predominant type of mathematics studied by the faculty person in his or her graduate program included six categories. These and their respective codes were 1 for fundamentals of arithmetic, 2 for Algebra, Trigonometry, and Geometry, 3 for Consumer Mathematics, and 4 for Calculus (Hathaway, 1983, pp. 56-57), 5 for computing and 6 for Statistics. Faculty persons with mixed scholastic records were classified in the category in which they have the greatest aggregate number of credit hours.

Coding of the faculty person's years of teaching experience at the college at which the study was conducted was divided into five categories. Less than two years of teaching experience at the college was represented by the symbol 1. Three to five years of teaching experience at the college was represented by the symbol 2. Six to ten years of teaching experience at the college was coded 3. 11 to 15 years of teaching experience at the college was coded 4. More than 15 years of teaching experience at the college was coded 5.

It was also possible that the faculty at the college could have experience teaching at another college in mathematics or another discipline. The potential effect of this circumstance was investigated. It was described as cumulative college teaching experience. The coding of cumulative college teaching experience was the same as years of experience at the college for zero to ten years of experience. Code 4 represented 11 to 15 years of cumulative college teaching experience. The code 5 represented 16 to 20

years of cumulative college teaching experience. The code 6 represented 21 or more years of college teaching experience.

There are five possible faculty statuses at the research site. Part time faculty cannot advance in rank. Part time or adjunct status, while a possible faculty rank subcategory, was considered an employment status and was not reconsidered as a rank. The remaining faculty ranks were Instructor, Assistant Professor, Associate Professor and Full Professor (RCC Faculty Senate, n.d.).

All full time faculty at the college enter with the rank of Instructor (RCC Faculty Senate, n.d.). By completing three years of service, accruing 10 service points, successfully completing an interview with the Faculty Rank Committee and receiving approval from the college president faculty can advance to the rank of Assistant Professor (RCC Faculty Senate, n.d.). Advancement from Assistant Professor to Associate Professor requires a minimum of an additional 4 years of teaching, 20 more service points, filling leadership roles at the college, drafting a narrative of service acceptable to the Faculty Rank Committee, successfully completing an interview with the Faculty Rank Committee and receiving approval from the college president (RCC Faculty Senate, n.d.). Once a faculty person has achieved the rank of Associate Professor, an additional six years of service at the college, an additional 30 service points, a second narrative describing instructional innovation during the period as an Associate Professor, a successful interview with the Faculty Rank Committee and approval from the college president are required to reach the rank of Full Professor (RCC Faculty Senate, n.d.). These ranks were coded 1 for Instructor, 2 for Assistant Professor, 3 for Associate Professor and 4 for Full Professor.

Data Analysis

Measures of central tendency and variability, as applicable, were calculated to describe the raw data (Ary, Jacobs, Razavieh, & Sorensen, 2006, pp. 127-135). These results are presented on tables in the results section of this document. The data is displayed by variable and by course level, MAT 060, MAT 070, and MAT 080.

Comparisons of the observed frequencies in the data with expected frequencies were calculated as chi-square measures of independence (Ary, Jacobs, Razavieh, & Sorensen, 2006, pp. 577-578; Sullivan, 2005, p. 488). This calculation was employed to determine if there were significant differences between observed and expected values in the subsets of the data (Ary, Jacobs, Razavieh, & Sorensen, 2006, pp. 208-210, 578; Sullivan, 2005, pp. 488-490). As students randomly sort into classes, all the categories employed were mutually exclusive, and the observations were “measured as frequencies” (Ary, Jacobs, Razavieh, & Sorensen, 2006, p. 210), all the assumptions related to chi-square statistical analysis were met by the data set. The calculations were performed by the Excel program based upon worksheets created for this purpose (Dretzke, 2005, p. 277). The results of the chi-square calculations are presented in this document in the next chapter and also referred to in the final chapter of this document.

In addition to chi-square calculations, p-values, “the probability of observing a sample statistic as extreme or more extreme than the one observed under the assumption that the null hypothesis is true,” (Sullivan, 2005, p. 397) were calculated. P-values computation was performed by formulas embedded in Excel worksheets (Dretzke, 2005). The results confirmed the accuracy of the chi-square calculations and aided in interpretation of outcomes.

The findings related to each of the hypotheses formed from the research hypothesis are included in the dissertation in tabular form. These tables represent the findings at each level of instruction in developmental mathematics, MAT 060, MAT 070, and MAT 080. These findings are utilized in the results, conclusions, and implications and applications sections of the dissertation.

Summary

The purpose of this ex post facto study was to investigate the association of selected personal and experiential characteristics of faculty with student success rate in developmental mathematics at a rural North Carolina community college (Creswell, 1994, p. 64). The investigation was structured using the Astin I-E-O model (1968; 1976; 1991). Access to the data and site was approved by the president of the college. No instruments were designed or used in the study. The sample included all students active in classroom based developmental mathematics instruction between fall of 2003 and spring of 2007. The statistical analysis performed was chi-square measures of independence (Ary, Jacobs, Razavieh, & Sorensen, 2006, pp. 577-578; Sullivan, 2005, p. 488) and p-value calculations (Sullivan, 2005).

CHAPTER 4 – RESULTS

This dissertation addresses a concern common to all regions of the United States, all institutions of higher education, and to the future of the American work force, student success rates in developmental mathematics. The dependent variable in the study was student success rate in developmental mathematics. Success was defined as receiving a passing grade, a C or better, in the course. The research problem can be stated in the following manner: The purpose of this ex post facto study was to investigate the association of selected personal traits and experiential characteristics of faculty with student success rate in developmental mathematics at a rural North Carolina community college (Creswell, 1994, p. 64). The personal and experiential characteristics of faculty which served as independent variables were: faculty age, gender, employment status (full time or part time), residence in the county served by the college, instructional experience in secondary education, present employment in secondary education, possession of a degree from a community college, holding only a bachelor's degree, possession of an undergraduate degree in Education, possession of an advanced degree in Education, hours of graduate mathematics studied, predominant type of mathematics studied in graduate school (Hathaway, 1983), years of instructional experience in higher education, years of instructional experience at the college and faculty academic rank. Each of these variables was investigated in regard to its effect on student success rates in semester length courses in remedial mathematics at a rural North Carolina community college.

Sample

The sample size was large. 3,918 students took classroom based developmental mathematics courses in the period of the study. This allowed for homogeneous groupings of subjects to be formed when analyzing data as a control for the effects of intervening variables (Ary, Jacobs, Razavieh & Sorensen, 2006, p. 368; Astin, 1998; Creswell, 1994, p. 64). The homogenous groups were the three levels of developmental mathematics study. As described in the methodology chapter of this dissertation, these class levels were homogenous groups since students were placed in the courses based upon skill demonstrated in mathematics on a standardized instrument.

Each of the instructional levels represented a large portion of the sample. The number of students who took MAT 060 Essential Mathematics (RCC, 2007), the lowest level course, was 1,205. 2,003 students took MAT 070 Introductory Algebra (RCC, 2007) in traditional classroom settings during the period of the study. The cumulative count of students for MAT 080 Intermediate Algebra (RCC, 2007), the highest level course, during the study was 710 students.

In general, student success rates showed an inverse relationship to level of instruction. When data from all classroom sections at three levels instruction across the period of the study is considered, the average passing rates were 57.93% in MAT 060, 52.57% in MAT 070 and 43.38% in MAT 080.

Results

In this chapter the results of the statistical analysis of the data set will be presented. Prior to considering the relationship of faculty characteristics and student

outcomes the characteristics of the developmental mathematics faculty are described. Following that, the results are considered one independent variable at a time.

Overview of the Faculty

The developmental mathematics faculty at the research site is in some ways representative of American community college faculty and in other measures shows marked differences. In respect to employment status, age and degrees held the faculty was an approximation of the average faculty pool at an American community college (Table 4.1). However, in respect to race, gender and academic rank the composition of the developmental mathematics faculty was different than the average community college faculty in the United States. All the developmental mathematics faculty at the college during the period of the study were White while approximately 80% of community college faculty are White (Table 4.1). The second area which exhibited a large difference from national averages was the proportion of males and females. The research site faculty was skewed female by nearly 30 percentage points (Table 4.1). There were some idiosyncratic results in faculty rank. At the college which served as the research site there were more faculty in the middle ranks than would be expected and approximately half the average number at the highest rank (Table 4.1). The potential significance of these demographics will be described, as applicable, in final chapter of this document.

Table 4.1

Developmental mathematics faculty at the research site compared to national averages for community college faculty

Characteristic			National averages			
	Full time	Part time	Phillipe & Sullivan (2005)		NCES (2003)	
			Full time	Part time	Full time	Part time
White	100.0%	100.0%	83.0%	76.7%	81.2%	83.8%
Male	22.2%	13.3%	49.0%	-	51.3%	52.3%
Female	77.8%	87.7%	51.0%	-	48.7%	47.7%
Employment status	37.5%	62.5%	33.2%	66.8%	35.7%	64.3%
Younger than 35 yrs.	0.0%	6.7%	6.5%	12.1%	7.0%	12.3%
Age 35-44 yrs.	44.4%	26.7%	21.9%	25.8%	22.2%	22.5%
Age 45-54 yrs.	22.2%	33.3%	41.2%	37.3%	34.4%	30.4%
Age 55+ yrs.	22.2%	33.3%	30.3%	24.7%	36.4%	34.8%
Graduate degree	88.9%	53.3%	83.8%	73.3%	81.0%	67.1%
Bachelor's degree	11.1%	46.7%	12.9%	19.2%	18.0%	32.9%
Full Professor	11.1%	6.7%	-	-	21.5%	3.4%
Associate Professor	22.2%	0.0%	-	-	11.3%	1.5%
Assistant Professor	33.3%	0.0%	-	-	10.2%	1.0%
Instructor	33.3%	0.0%	-	-	39.5%	49.5%

Independent Variable Results

The independent variables selected for investigation in this project were divided into the categories personal and experiential factors. Instructor age, gender, employment status and residence in the county served by the college were considered personal traits. County residence was included as a surrogate for cultural affiliation and understanding. The characteristics of faculty considered as independent variables in the study which were classified as experiential factors include secondary teaching experience, concurrent employment at the college and in secondary education, possession of a degree from a community college, type of four year institution attended, holding only a bachelor's degree, possession of an undergraduate degree in Education or an advanced degree in Education, hours of graduate mathematics studied, predominant type of mathematics studied in graduate school (Hathaway, 1983), years of instructional experience in higher education, years of instructional experience at the college and faculty academic rank. For the purposes of this discussion the experiential characteristics were divided into three subcategories, experience with secondary education, educational background, and college teaching experience. The results will be discussed in the order personal traits, experience with secondary education, educational background, and college teaching experience.

The data set included student outcomes at each of three levels of developmental mathematics. The results are summarized on tables by independent variable and by class level. For example, Table 4.2 represents the statistical outcomes for the relationship between the personal traits of faculty and student outcomes in the lowest level of developmental mathematics at the college, MAT 060 Essential Mathematics (RCC, 2007). Table 4.3 provides the statistical outcomes for the relationship between the

faculty's personal traits and student outcomes in the middle level of developmental mathematics at the college, MAT 070 Introductory Algebra (RCC, 2007). Table 4.4 lists the statistical outcomes for the relationship between the faculty traits and student outcomes in the upper level of developmental mathematics at the college, MAT 080 Intermediate Algebra (RCC, 2007). Each table includes the student success rate for faculty not exhibiting the characteristic and for faculty exhibiting the characteristic. The labels for these columns are "Non-subject" and "Subject" under the heading "Passing Percentage." These two columns are followed by columns listing the p-value, the alpha value (α), the critical chi-square value and the observed chi-square value. Statistical significant for all variables was sought at the 0.05 level and higher. On the tables which follow, α values are at the 0.05 level unless the independent variable was statistically significant at a higher level. In these cases, the alpha level at which the variable is statistically significant is listed.

Personal Traits of Faculty

Faculty age. As described above, Tables 4.2, 4.3 and 4.4 list the results from the statistical analysis of the relationship of faculty personal traits and student outcomes. The first characteristic listed is faculty age.

Faculty age was divided by decades. Faculty under the age of 35 were in one group, those 35 to 44 in the second, those 45 to 54 in the third and those over the age of 55 in a fourth group. One part time instructor was under the age of 35. This person taught only one semester during the period of the study and only one class of 16 students in that semester. As this group was too small to be representative, statistical analysis was not completed for the under 35 age category. The number of faculty in each of the remaining

categories and the sample sizes associated with each category were sufficient to allow statistical analysis.

Eight instructors were between the ages of 35 and 44. All of these persons were female. Four were part time instructors and four were full time instructors. The cumulative totals of students taught by this group were 720 in MAT 060, 999 in MAT 070 and 502 in MAT 080. Seven instructors were between the ages of 45 and 54. Two of these faculty members were male, one a part time instructor and the other a full time instructor. The other five faculty who were 45 to 54 years of age were females. One of the female instructors had full time status. The other four were part time instructors. The 45 to 54 year olds taught 169 students in MAT 060, 377 in MAT 070 and 69 in MAT 080 during the period of the study. Eight instructors were over the age of 55. Two of these persons were male, one a full time instructor and the other a part time instructor. The remaining six instructors over the age of 55 were females. Two of the females over the age of 55 were full time instructors and four were part time instructors. Persons over the age of 55 taught 300 students in MAT 060, 627 students in MAT 070 and 139 students in MAT 080. The age categories 35 to 44, 45 to 54 and over 55 years included groups which represented the diversity in respect to gender and employment status among the faculty and student samples that were representative.

The null hypothesis for instructor age was faculty age is independent of student success rates in developmental mathematics at the college. It was not supported for 45 to 54 year old instructors teaching MAT 080. These persons had a statistically significant relationship to lower than expected student success in MAT 080 at an α of .02 and a p-value of 0.0111 (Table 4.4).

The statistical results for faculty age exhibited a number of additional patterns. Student outcomes differed from one faculty age group to the next. Even the impact of instruction by faculty in one age group was not uniform. It varied across the three levels of instruction in direction, in probability of occurring at random and in statistical significance.

Table 4.2

Personal traits of faculty and student outcomes for MAT 060

Variable	<u>Passing percentages</u>		P-value	Alpha	Critical value	Observed chi-square
	Non-subject	Subject				
Age 35-44	59.79%	56.67%	0.2809	0.05	3.8414	1.1628
Age 45-54	56.85%	64.50%	0.0620	0.05	3.8414	3.4832
Age 55+	58.45%	56.33%	0.5193	0.05	3.8414	0.4154
Male	58.19%	54.55%	0.5047	0.05	3.8414	0.4450
Female	54.55%	58.19%	0.5047	0.05	3.8414	0.4450
Full time	55.19%	61.30%	0.0327	0.04	4.2179	4.5623
Part time	61.30%	55.19%	0.0327	0.04	4.2179	4.5623
County resident	62.21%	56.51%	0.0837	0.05	3.8414	2.9919

Table 4.3

Personal traits of faculty and student outcomes for MAT 070

Variable	<u>Passing percentages</u>		P-value	Alpha	Critical value	Observed chi-square
	Non-subject	Subject				
Age 35-44	51.89%	53.25%	0.5420	0.05	3.8414	0.3719
Age 45-54	53.51%	48.54%	0.0820	0.05	3.8414	3.0250
Age 55+	51.96%	53.91%	0.4188	0.05	3.8414	0.6537
Male	53.62%	48.19%	0.0549	0.05	3.8414	3.6866
Female	48.19%	53.62%	0.0549	0.05	3.8414	3.6866
Full time	47.67%	56.57%	0.0001	0.01	6.6349	15.7621
Part time	56.57%	47.67%	0.0001	0.01	6.6349	15.7621
County resident	54.45%	51.47%	0.1970	0.05	3.8414	1.6641

Table 4.4

Personal traits of faculty and student outcomes for MAT 080

Variable	<u>Passing percentages</u>		P-value	Alpha	Critical value	Observed chi-square
	Non-subject	Subject				
Age 35-44	37.98%	45.62%	0.0617	0.05	3.8414	3.4919
Age 45-54	44.93%	28.99 %	0.0111	0.02	5.4119	6.4476
Age 55+	43.61%	42.45%	0.8043	0.05	3.8414	0.0614
Male	44.91%	32.97%	0.0318	0.04	4.2179	4.6081
Female	32.97%	44.91%	0.0318	0.04	4.2179	4.6081
Full time	33.92%	46.38%	0.0042	0.01	6.6349	8.2109
Part time	46.38%	33.92%	0.0042	0.01	6.6349	8.2109
NC native	41.98%	44.11%	0.5858	0.05	3.8414	0.2969
County resident	48.15%	40.90%	0.0644	0.05	3.8414	3.4193

Faculty gender. The developmental mathematics faculty at the research site was approximately 78% female among full time instructors and approximately 88% female in the part time instructor group (Table 4.1). Four of the 24 faculty members in the study were male, two full time and two part time instructors. The male instructor group included persons in the 45 to 54 and over 55 age groups with one full time and one part time instructor in each age group. Female faculty included persons in every age category employed for the study seven of whom were full time instructors and 13 of whom were part time instructors. Female faculty members taught 1,117 students in MAT 060, 1,617 students in MAT 070 and 619 students in MAT 080. Male faculty taught 88 students in MAT 060, 386 in MAT 070 and 91 in MAT 080. Both faculty groups showed sufficient diversity in respect to employment status and age and had student samples that were large enough to be representative.

The null hypothesis for faculty gender was the gender of faculty is independent of student success rates in developmental mathematics at the college. This hypothesis was not supported in MAT 080. A statistically significant relationship was found between instructor's gender and student success rate at the upper level of instruction. In MAT 080, the association was significant at an $\alpha = 0.04$ level with a p-value of 0.0318 (Table 4.4). In MAT 070, the relationship was within one-half of a percentage point of significance with a p-value of 0.0549 (Table 4.3). At each level of instruction, males were associated with lower than expected student success rates while females were associated with higher than expected success rates, trend worth noting.

The statistical analysis for faculty gender exhibited the same patterns found for faculty age and an additional pattern was present. Each gender had different relationships

to student outcomes. The impact of instruction by faculty of one gender was uniform in direction, higher or lower than expected, but varied in strength across the three levels of instruction. Male faculty had lower passing rates than female faculty at every level of instruction. This difference was nearly statistically significant in MAT 070 and was statistically significant in MAT 080.

Faculty employment status. The developmental mathematics faculty at the research site were similar to the average American community college faculty in respect to employment status. Over 60% of the faculty were employed part time (Table 4.1). However, the research site faculty included more females than the average American community college faculty, 78% of the full time faculty and 88% of the part time faculty (Table 4.1). There were 15 part time faculty, two of whom were male, and nine full time faculty, two of whom were male. The full time faculty included persons in every age group except below 35 years of age. The part time faculty included persons in every age group. Faculty of each employment status taught large numbers of students. The full time faculty taught 540 students in MAT 060, 1,103 students in MAT 070 sections and 539 students in MAT 080 sections while part timers taught 665 students in MAT 060 sections, 900 students in MAT 070, and 171 students in MAT 080. The employment status groupings were sufficiently diversity in respect to gender and age to limit the influence of these traits on the present comparison and the student samples associated with each group were large enough to be representative.

The null hypothesis for faculty employment status was faculty employment status is independent of student success rates in developmental mathematics at the college. This hypothesis was not supported at any of the levels of instruction (Table 4.2, 4.3, 4.4). At

all levels of instruction, full time faculty status was significantly associated with higher than expected student outcomes, at an α of 0.04 with a p-value of 0.0327 in MAT 060 (Table 4.2), at $\alpha = 0.01$ with a p-value of 7.2×10^{-5} in MAT 070 (Table 4.3) and at $\alpha = 0.01$ with a p-value of 0.0042 in MAT 080 (Table 4.4). Part time faculty status was significantly associated with lower than expected student outcomes at the same values as the calculation compared observed values for full time and part time faculty with the expected values.

The statistical analysis for faculty employment status exhibited two of the patterns found for faculty age and gender and one new pattern. The employment statuses had different relationships to student outcomes. The impact of instruction by faculty of one employment status was not uniform strength, which varied across the three levels of instruction. However, the direction of the relationship was uniform for each group. Faculty employment status is the first personal trait of faculty to demonstrate a statistically significant relationship with student success rate across all three levels of instruction (Table 4.2, 4.3, 4.4).

County resident. Of the faculty who chose to reside in the county served by the college, one was a male full time instructor, two were male part time instructors, three were female full time instructors and 11 were female part time instructors. The county residents included faculty in all age groups other than the under 35 category. Faculty residing outside the county were one male full time instructor, four female full time instructors and two female part time instructors. Every age category was represented in this group. Both county residents and residents of other counties taught large numbers of students. County residents taught 906 students in MAT 060 sections, 1,261 students in

MAT 070 sections and 467 students in MAT 080 sections. Residents of other counties taught 299 MAT 060 students, 742 MAT 070 students and 243 MAT 080 students. The faculty groups “county resident” and residents of other counties exhibited sufficient diversity in respect to age, gender and employment status to prevent strong influence on the results of the present comparison by these traits and the student samples associated with the groups were large enough to be representative.

The null hypothesis for the variable “county resident” was faculty residence in the county served is independent of student success rates in developmental mathematics at the college. This hypothesis was supported at all three levels of instruction (Table 4.2, 4.3, 4.4)

The statistical analysis for status as county resident exhibited patterns similar to those reported for faculty age. Student outcomes differed between the two faculty groups. Even the impact of instruction by faculty in one group was not uniform. It varied across the three levels of instruction in probability of occurring at random. However, faculty residing outside the county were associated with higher than expected student success and those residing within the county with lower than expected student success at all three levels of instruction.

Secondary education experience

The statistical results related to the relationship of experiential characteristics of the college developmental mathematics faculty and student outcomes are portrayed in Tables 4.5 through 4.18. These will be addressed in the order experience with secondary education, educational background and college teaching experience.

Table 4.5 displays the statistical results for the data related to the secondary teaching experience of the college's developmental mathematics faculty. There were two related constructs investigated, instructional experience in secondary education and simultaneous employment in secondary education and at the college.

Nineteen of the developmental mathematics faculty had experience in secondary education. This group was comprised of one male part time instructor, two male full time instructors, six female full time instructors and 10 female part time instructors. All the age categories for faculty employed in the study were represented in this group. There were five faculty without secondary teaching experience. They were one male part time instructor, one female full time instructor and three female part time instructors. All the age categories for faculty employed in the study except the under 35 years of age category were represented among these five persons. Both groups taught large numbers of students. Faculty with secondary teaching experience taught 895 students in MAT 060, 1,505 students in MAT 070 and 516 students in MAT 080. Faculty without secondary teaching experience taught 310 students in MAT 060, 498 students in MAT 070 and 194 students in MAT 080. Faculty grouped by instructional experience in secondary education exhibited sufficient diversity in respect to age, gender and employment status to limit the impact of these traits on the present comparison and the student samples associated with the groups were large enough to be representative.

Six of the developmental mathematics faculty held teaching positions in secondary education while serving as instructors at the college. This group was comprised of female part time instructors. All the age categories for faculty employed in the study were represented among these six persons. Eighteen of the developmental

mathematics faculty were not employed simultaneously in secondary education and by the college. Two male part time instructors, two male full time instructors, seven female part time instructors and seven female full time instructors were in this group. All the age categories for faculty employed in the study except the under 35 years of age category were represented among these 18 persons. Both groups taught large numbers of students. The faculty teaching in both secondary settings and at the college taught sections of MAT 060, 070 and 080 with 191, 233, and 57 students respectively while the faculty teaching only at the college taught 1,014, 1,770 and 653 students in the courses. Faculty who are not employed simultaneously in secondary education and at the college exhibited sufficient diversity in respect to age and gender and employment status to limit an influence on the present comparison from these traits. However, the faculty with simultaneous employment lacked diversity in terms of gender and employment status. The student samples associated with the groups were large enough to be representative.

That all faculty exhibiting the characteristic simultaneous employment in secondary education were part time employees should be expected. That they were all female will be considered when interpreting the results. It is also important to note that the two independent variables, secondary teaching experience and simultaneous employment in secondary education and at the college, show substantial differences in the faculty groups exhibiting the characteristics. This is strong support for the presence of two independent variables.

The null hypothesis for instructional experience in a secondary education was instructional experience in a secondary education on the part of faculty is independent of student success rates in developmental mathematics at the college. The null hypothesis

for the second variable in this category was simultaneous employment at the college and in secondary education on the part of faculty is independent of student success rates in developmental mathematics at the college. Both hypotheses were supported at all three levels of instruction as there were no instances in which there were statistically significant results (Table 4.5). However, several of the results patterns observed in respect to other variables are supported by the results for these variables.

Even though none of the results were statistically significant at an α level of 0.05 or less, the following can be said about the results. The impact of instruction by faculty with instructional experience in secondary education was not uniform. It varied across the three levels of instruction in strength and direction.

Table 4.5

Faculty members' experience in secondary education and student outcomes

Variable	Passing percentages		P-value	Alpha	Critical value	Observed chi-square
	Non-subject	Subject				
MAT 060 Essential Mathematics						
Secondary experience	56.45%	58.44%	0.5420	0.05	3.8414	0.3719
Simultaneous secondary involvement	57.30%	61.26%	0.3093	0.05	3.8414	1.0335
MAT 070 Introductory Algebra						
Secondary experience	50.20%	53.36%	0.2217	0.05	3.8414	1.4935
Simultaneous secondary involvement	52.54%	52.79%	0.9433	0.05	3.8414	0.0051
MAT 080 Intermediate Algebra						
Secondary experience	45.88%	42.44%	0.4106	0.05	3.8414	0.6771
Simultaneous secondary involvement	44.26%	33.33 %	0.1105	0.05	3.8414	2.5470

Educational Background of Faculty

Community college graduate. Four of the college's developmental mathematics faculty were graduates of a community college. One male part time instructor, one female full time instructor and two female part time instructors were in this group. These faculty members were in the age categories 45 to 54 years of age and 55 years of age or older and taught 137 students in MAT 060, 338 students in MAT 070 and 15 students in MAT 080. The remaining 20 faculty persons who represented all possible age categories, both genders and both employment statuses taught 1,068 students in MAT 060, 1,665 students in MAT 070 and 695 students in MAT 080. The two groups exhibited sufficient diversity in respect to age, gender and employment status to limit concern regarding the impact of these traits on the present comparison. However, the student samples associated with the groups were not large enough to be representative at all three levels of instruction. The sample size for faculty who graduated from a community college at the MAT 080 instructional level was too small to be considered representative and statistical analysis was not completed for this level of instruction.

The first construct related to education background considered on Tables 4.6, 4.7 and 4.8 is graduation from a community college. The null hypothesis for this construct was instruction from faculty who graduated from a community college is independent of student success rates in developmental mathematics at the college. The null hypothesis for faculty having graduated from a community college was supported at both the MAT 060 and 070 levels of instruction (Table 4.6, 4.7).

The results for this variable represent a pattern not yet exhibited by an independent variable in this study. The results at the MAT 060 and 070 instructional

levels are very likely to have occurred at random as indicated by the p-values of 0.9476 for MAT 060 and 0.9343 for MAT 070. This would indicate that graduation from a community college is a characteristic of the faculty group researched which has no bearing on student success rates in developmental mathematics.

Table 4.6

Educational background of faculty and student outcomes for MAT 060

Variable	<u>Passing percentages</u>		P-value	Alpha	Critical value	Observed chi-square
	Non-subject	Subject				
CC graduate	57.96%	57.66%	0.9476	0.05	3.8414	0.0043
B.S. only	57.66%	58.43%	0.7972	0.05	3.8414	0.0661
B.S. Education	57.11%	59.40%	0.4400	0.05	3.8414	0.5961
Grad. = Education	58.33%	57.14%	0.6911	0.05	3.8414	0.1578
Grad. study = Algebra	58.73%	56.22%	0.4097	0.05	3.8414	0.6796
Grad. study = Calculus	57.42%	62.50%	0.2847	0.05	3.8414	1.1444
Grad. study = Comptr.	59.53%	44.62%	0.0011	0.01	6.6349	10.5923
Grad. study = Stats	56.36%	68.13%	0.0050	0.01	6.6349	7.8754

Table 4.7

Educational background of faculty and student outcomes for MAT 070

Variable	Passing percentages		P-value	Alpha	Critical value	Observed chi-square
	Non-subject	Subject				
CC graduate	52.61%	52.37%	0.9343	0.05	3.8414	0.0068
B.S. only	51.90%	55.06%	0.2472	0.05	3.8414	1.3389
B.S. Education	51.95%	53.72%	0.4495	0.05	3.8414	0.5720
Grad. = Education	54.29%	50.68%	0.1067	0.05	3.8414	2.6020
Grad. study = Algebra	53.47%	51.68%	0.4222	0.05	3.8414	0.6443
Grad. study = Calculus	52.38%	60.42%	0.2705	0.05	3.8414	1.2140
Grad. study = Comptr.	53.72%	44.71%	0.0071	0.01	6.6349	7.2496
Grad. study = Stats	51.73%	58.11%	0.0524	0.05	3.8414	3.7621

Table 4.8

Educational background of faculty and student outcomes for MAT 080

Variable	<u>Passing percentages</u>		P-value	Alpha	Critical value	Observed chi-square
	Non-subject	Subject				
CC graduate	43.38%	N/A				
B.S. only	43.53%	41.51%	0.7751	0.05	3.8414	0.0816
B.S. Education	43.68%	41.88%	0.7202	0.05	3.8414	0.1283
Grad. = Education	46.34%	38.22%	0.0357	0.04	4.2179	4.4137
Grad. study = Algebra	43.92%	42.77%	0.7589	0.05	3.8414	0.0942
Grad. study = Calculus	43.38%	N/A				
Grad. study = Comptr.	44.67%	30.16%	0.0265	0.03	4.7093	4.9204
Grad. study = Stats	40.85%	47.71%	0.0750	0.05	3.8414	3.1690

Undergraduate degree only. The fourth line of Tables 4.6, 4.7 and 4.8 lists results for the comparison of faculty who completed a bachelor's degree with those who completed graduate degrees. The seven mathematics faculty who completed only a bachelor's degree include both of the male part time instructors, one of the female full time instructors and four of the female part time instructors. This group included persons in every age category for faculty except the under 35 years of age category. The remainder of the faculty included persons in every age category employed for faculty in the study, both genders and both employment statuses. The bachelor's degree only faculty taught 409 students in MAT 060 sections, 425 students in MAT 070 sections and 53 students in MAT 080 sections while the faculty with graduate degrees taught 796 students, 1,578 students and 657 students in these courses respectively. Considering the characteristics described above and large numbers of students taught by both groups, there was sufficient diversity in respect to age, gender and employment status in the faculty groups and student samples that were large enough to be representative.

The null hypothesis for this construct was instruction from a faculty person who has not participated in graduate studies is independent of student outcomes in developmental mathematics at the college. The null hypothesis was supported at all three levels of instruction for this construct (Tables 4.6, 4.7, 4.8). The only pattern apparent in the results for this construct is that instruction from faculty persons who possesses only a bachelor's degree did not have a uniform impact on student success rates in developmental mathematics at the college as the strength and direction of the results varied from course level to course level.

Undergraduate degree in Secondary Education. The impact of instruction by a faculty person in developmental mathematics who holds an undergraduate degree in secondary education is the construct following bachelor's degree only on Tables 4.6 through 4.8. Ten of the mathematics faculty held undergraduate degrees in secondary education. This group included a male part time instructor, a female full time instructor and nine female part time instructors who represented all the faculty age categories included in the study. The faculty who did not hold an undergraduate degree in secondary education included a male part time instructor, both male full time instructors, six of seven female full time instructors and four female part time instructors. Both groups taught large numbers of students. Faculty with undergraduate degrees in secondary education taught 309 MAT 060 students, 552 MAT 070 students and 86 MAT 080 students while those without undergraduate degrees in secondary education taught 896 MAT 060 students, 1,451 MAT 070 students and 624 MAT 080 students. The student samples for each group were large enough to be representative. The distribution of genders and age was sufficient in the two groups. However, the predominance of part time faculty in the undergraduate degree in secondary education group, given the results reported above, indicates the presence of a confounding variable. That between two-thirds and three-quarters of the students in this category were taught by part time faculty indicated a strong influence on the results exerted by this trait.

The null hypothesis for this construct was instruction from a faculty person who has an undergraduate degree in Secondary Education is independent of student outcomes in developmental mathematics at the college. The null hypothesis was supported at all three levels of instruction for this construct (Tables 4.6, 4.7, 4.8). The only pattern

apparent in the results for this construct is that instruction from faculty persons who possesses an undergraduate degree in secondary education did not have a uniform impact on student success rates in developmental mathematics at the college as the strength and direction of the results varied from course level to course level, a pattern which may have been influenced by the predominance of part time faculty in the undergraduate degree in secondary education group.

Graduate degree in Education. The fifth variable listed on Tables 4.6 through 4.8 is holding a master's degree or doctorate in Education. Of the 24 mathematics faculty members included in the study, 12 held a master's degrees in Education. One male full time faculty person in this group held both a master's degree and doctorate in Education. This group was comprised of two male full time faculty members, three female full time faculty members and seven female part time faculty members. The faculty without a master's degree in Education were two male part time faculty members, four female full time faculty members and six female part time faculty members. Each group taught large numbers of students. Faculty with graduate degrees in Education taught 413 MAT 060 students, 953 MAT 070 students and 259 MAT 080 students while those without graduate degrees in Education taught 792 MAT 060 students, 1,050 MAT 070 students and 451 MAT 080 students. There was sufficient diversity in respect to age, gender and employment status in the faculty groups to limit the influence of these traits on the present comparison and student samples that were large enough to be representative.

The null hypothesis in this area was instruction from faculty members who hold graduate degrees in Education is independent of student success rates in developmental mathematics at the college. The null hypothesis was supported at the MAT 060 and MAT

070 levels (Tables 4.6, 4.7). It was not supported at the MAT 080 level where there was a statistically significant negative correspondence at the $\alpha = 0.04$ level with a p-value of 0.0357 (Table 4.8).

The results for this construct are similar to those for employment status and type of undergraduate institution. There was a uniform impact across all three levels of instruction. In this instance, the uniformity was in respect to the negative nature of relationship. The success rates of students taught by faculty with graduate degrees in Education were lower at each level of instruction than that for students taught by faculty who do not hold graduate degrees in Education. The relationship was not statistically significant in MAT 060 or in MAT 070 and was statistically significant in MAT 080 at $\alpha = 0.04$ with a p-value of 0.0357.

Predominant type of mathematics studied. Among the developmental mathematics faculty at the college there were four areas of concentration in graduate studies. These were Algebra, Calculus, Computers and Statistics. When the faculty was divided into these four categories small groups with the potential for impact by confounding characteristics were formed and some levels of instruction included too few students to be representative.

The 12 faculty who studied Algebra in graduate school included both male full time faculty, three female full time faculty and seven female part time faculty. All age categories for faculty included in the study were found in this group. Only two faculty members studied Calculus in graduate school. They were a 45 to 54 year old, female, full time faculty member and a 35 to 44 year old, female, part time faculty member. Two 35 to 44 year old faculty studied Statistics in graduate school. Both were female, full time

faculty members. One 35 to 44 year old faculty person studied Computers in graduate school. She was a part time instructor who taught a large number of sections of developmental mathematics during the period of the study. The only category which had sufficient diversity in age, gender and employment status to avoid obvious influence of potentially confounding variables was faculty who studied Algebra in graduate school. Each of the other categories was limited in diversity or represented no diversity in respect to instructor age, gender and employment status. The interpretation of the results must take these patterns into account.

The faculty who completed only a bachelor's degree were treated as a separate independent variable in this study and were not included as a subcategory of this variable. However, the success data for their students were included in the "Non-subject" percentages used for the comparisons as they represented a portion of the faculty that did not exhibit the characteristic under consideration.

Each of the four graduate study specialization groups taught student samples at all levels of instruction that were large enough to be considered representative. Algebra majors taught 386 MAT 060 students, 1,010 MAT 070 students and 332 MAT 080 students. Calculus majors taught 120 MAT 060 students and 48 MAT 070 students. An idiosyncrasy of this group was one instructor taught all the MAT 060 sections and the other taught all the MAT 070 sections. Statistics majors taught 160 MAT 060 students, 265 MAT 070 students and 262 MAT 080 students with both instructors active at every level. The lone Computer major taught 130 MAT 060 students, 255 MAT 070 students and 109 MAT 080 students. As this part time faculty person taught over 10% of all the students included in the study at each instructional level, the results were reported.

The null hypothesis related to this construct was the type of mathematics studied by faculty members in graduate school is independent of student success rates in developmental mathematics at the college. This hypothesis was upheld at all three levels of instruction for the majors Algebra and Calculus (Tables 4.6, 4.7, 4.8). However, the chi-square and p-value calculations did not support it in respect to having Computers as the major area of study. This was the case at all three levels of instruction and all three of these relationships were negative. The relationship between the faculty person who studied computing in graduate school and student success rates was statistically significant at the 0.01 level with a p-value of 0.0011 in MAT 060 (Table 4.6), at the 0.01 level with a p-value of 0.0071 in MAT 070 (Table 4.7), and at the 0.03 level with a p-value of 0.0265 in MAT 080 (Table 4.8). In contrast, the major area of study Statistics had significant correspondence with higher than expected student success rates at the lowest level of instruction. The α level was 0.01 with a p-value of 0.0050. At the MAT 070 level, the relationship of faculty who studied predominantly statistics was a quarter of a percentage point outside the level of significance with a p-value of 0.0524. At the MAT 080 level the same instructors were associated with higher than expected outcomes, although not in a statistically significant manner as defined for this study, with a p-value of 0.0750 (Table 4.6, 4.7, 4.8).

The only independent variable reported prior to graduate studies concentrated in Computers with statistically significant results at all three levels of instruction which exhibited the same directional relationship at all three levels of instruction was faculty employment status. That the negative relationship between a major in Computers and student success rates had one-tenth of one percent likelihood at the MAT 060 level,

seven-tenths of one percent likelihood at the MAT 070 level, and 2.6% likelihood at the MAT 080 level of occurring at random indicates a very strong relationship exists between a characteristic or combination of characteristics of the single faculty member in this category and student success rates. A positive relationship between the two full time faculty with a graduate major in Statistics and student success also existed. The likelihood that this relationship would occur by chance was one-half of one percent in MAT 060, 5.24% in MAT 070 and 7.5% in MAT 080. The MAT 060 result is strongly statistically significant while the other two fall outside the range of statistical significance as defined for this study.

Hours of graduate mathematics studied. The developmental mathematics faculty at the college had a variety of experience in graduate education, none up to the possession of a doctorate in Education. Graduate hours earned in mathematics by faculty during these studies were classified as none, one to 18 hours, 19 to 36 hours and 37 or more hours.

The subcategory “None” was include for this variable. This represents faculty who had no graduate credit hours in mathematics reported in their personnel file. This group does not have a one-to-one correspondence with the bachelor’s degree only variable previously reported. There were faculty who had initiated a graduate program but had not completed it. These persons were a part of the calculations for the bachelor’s degree only variable but were not included in the “None” subcategory for graduate hours of mathematics studied.

The faculty grouped in the four subcategories of graduate hours in mathematics taught sufficient numbers of students for the samples to be considered representative but

some of them exhibited limited diversity in respect to faculty age, gender and employment status. The eight faculty members with no graduate study in mathematics reported in their personnel file included two male part time instructors, one female full time instructor and five female part time instructors. These faculty members were in the three age categories beginning at 35 to 44 years of age and extending through 55 years of age and older. They taught 539 MAT 060 students, 680 MAT 070 students and 116 MAT 080 students. The seven faculty members with one to 18 hours of graduate mathematics study reported in their personnel files included one female full time faculty person and six female part time faculty persons. This group had members in all four of the faculty age categories. They taught 251 MAT 060 students, 496 MAT 070 students and 169 MAT 080 students. The six faculty members with 19 to 36 graduate hours of credit in mathematics reported in their personnel file included two male full time instructors, two female full time instructors and two female part time instructors. These faculty members were in the three age categories beginning at 35 to 44 years of age and extending through 55 years of age and older. The faculty with 37 or more hours of graduate study were three female full time instructors. Two of these women were in the 35 to 44 age group and the third was in the 45 to 54 age group. They taught 208 MAT 060 students, 174 MAT 070 students and 189 MAT 080 students. The make up of each group will be a consideration when interpreting the study results as subcategories of this variable existed in which all the faculty were female or full time faculty. These constructs were demonstrated to have a strong impact on student success rates at the research site.

The null hypothesis for graduate hours of mathematics was the number of graduate hours completed in mathematics by faculty members is independent of student

success rates in developmental mathematics at the college. This hypothesis was supported at 11 of the 12 points of analysis. At the MAT 070 level, there was a positive relationship between faculty with 37 or more hours of graduate credit in mathematics and student success rates at the 0.02 level with a p-value of 0.0136 (Table 4.9). Three other comparisons are worth noting as they support a general pattern in the 12 comparison matrix. At the MAT 060 level, faculty with no graduate hours in mathematics were associated with lower than expected student outcomes with a p-value of 0.0741 and faculty with 19 to 36 hours of graduate credit in mathematics with higher than expected outcomes with a p-value of 0.0613 (Table 4.9). At the MAT 080 level, there was a negative relationship between faculty with no hours of graduate credit in mathematics and student success rates with a p-value of 0.0562 (Table 4.9).

The results for each of the subcategories will require cautious interpretation for the reasons given above. However, they include a general pattern. In the “None” and one to 18 hours subcategories the success rates for students are lower for faculty within the group than for those outside the group. In the 19 to 36 and 37 or more hours of graduate study in mathematics subcategories five of the six student success rates are higher than those associated with faculty outside these groups.

Table 4.9

Hours of graduate mathematics studied by faculty and student outcomes

Variable	<u>Passing percentages</u>		P-value	Alpha	Critical value	Observed chi-square
	Non-subject	Subject				
MAT 060 Essential Mathematics						
None	60.21%	55.10%	0.0741	0.05	3.8414	3.1895
1 to 18 hours	58.49%	55.78%	0.4384	0.05	3.8414	0.6004
19 to 36 hours	56.71%	63.77%	0.0613	0.05	3.8414	3.5009
37 or more hours	57.07%	62.02%	0.1886	0.05	3.8414	1.7228
MAT 070 Introductory Algebra						
None	53.29%	51.18%	0.3702	0.05	3.8414	0.8031
1 to 18 hours	52.82%	51.81%	0.6972	0.05	3.8414	0.1514
19 to 36 hours	52.74%	52.22%	0.8270	0.05	3.8414	0.0478
37 or more hours	51.72%	61.49%	0.0136	0.02	5.4119	6.0849
MAT 080 Intermediate Algebra						
None	44.94%	35.34%	0.0562	0.05	3.8414	3.6449
1 to 18 hours	43.81%	42.01%	0.6809	0.05	3.8414	0.1691
19 to 36 hours	42.62%	44.92%	0.5603	0.05	3.8414	0.3391
37 or more hours	41.84%	47.62%	0.1699	0.05	3.8414	1.8841

Higher Education Experience

The developmental mathematics faculty at the college exhibited a broad spectrum of experience in higher education. This spectrum extended from the first semester of college teaching experience to 35 years of college teaching experience. Three constructs were investigated which are related to instructional experience in higher education. These are instructional experience in higher education, cumulative instructional experience at the research site, and the related construct faculty rank.

Cumulative instructional experience in higher education. There was a broad spectrum of instructional experience in higher education among the faculty at the college. The categories utilized to group this experience were less than two years, three to five years, six to 10 years, 11 to 15 years, 16 to 20 years and more than 21 years. With six categories analyzed in respect to student outcomes at three instructional levels there were 18 points of comparison. The faculty grouped in these subcategories taught sufficient numbers of students to be representative at nearly every point of comparison and showed sufficient diversity in respect to age, gender and employment status to minimize the impact of confounding factors in the first three subcategories.

There were eight faculty members with two or less years of instructional experience in higher education. One was a male part time instructor, one was a female full time instructor and the remaining six were female part time instructors. All faculty age categories included in the study were represented in this group which taught 365 MAT 060 students, 324 MAT 070 students and 119 MAT 080 students.

Five faculty had personnel records which indicated three to five years of higher education instructional experience. One was a male part time instructor, two were female

part time instructors and two were female full time instructors. All faculty age categories included in the study except younger than 35 years of age were represented in this group which taught 350 MAT 060 students, 748 MAT 070 students and 94 MAT 080 students.

Five faculty had six to 10 years of higher education instructional experience. One was a male full time instructor, two were female part time instructors and two were female full time instructors. All faculty age categories included in the study except younger than 35 years of age were represented in this group which taught 320 MAT 060 students, 618 MAT 070 students and 316 MAT 080 students.

Two faculty had 11 to 15 years of higher education instructional experience. One was a female part time instructor. The other was a female full time instructor. The full time instructor was in the 35 to 44 years of age category and the part time instructor was in the 55 years of age and older category. These instructors taught 94 MAT 060 students, 100 MAT 070 students and 115 MAT 080 students.

Two faculty had 16 to 20 years of higher education instructional experience. One was a female part time instructor. The other was a female full time instructor. The full time instructor was in the 55 years of age and older category and the part time instructor was in the 45 to 54 years of age category. These instructors taught 76 MAT 060 students, 172 MAT 070 students and 15 MAT 080 students.

Two faculty had personnel records which indicated 21 or more years of higher education instructional experience. One was a female part time instructor. The other was a male full time instructor. Both were in the 55 years of age and older category. These instructors taught no MAT 060 students, 41 MAT 070 students and 51 MAT 080 students.

The null hypothesis for faculty experience in higher education was a faculty person's cumulative years of instructional experience in higher education is independent of student success rates in developmental mathematics at the college. The null hypothesis was supported in all but two of the 18 points of comparison. Faculty with three to five years of higher education instructional experience who taught MAT 060 had a statistically significant association with lower than expected student success rates at the 0.05 level with a p-value of 0.0431 (Table 4.10). Faculty with six to 10 years of higher education instructional experience who taught MAT 060 had a statistically significant association with higher than expected student success rates at the 0.05 level with a p-value of 0.0388 (Table 4.10).

The results parallel a pattern previously described but in a marked manner. Every relationship between the passing rates of students taught by faculty in one of the subcategories to faculty not in that subcategory for MAT 060 is reversed for MAT 070 (Table 4.10, 4.11, 4.12).

Table 4.10

Faculty experience in higher education and student outcomes for MAT 060

Variable	<u>Passing percentages</u>		P-value	Alpha	Critical value	Observed chi-square
	Non-subject	Subject				
2 years or less	58.10%	57.53%	0.8562	0.05	3.8414	0.0329
3 to 5 years	59.77%	53.43%	0.0431	0.05	3.8414	4.0926
6 to 10 years	56.16%	62.81%	0.0388	0.05	3.8414	4.2699
11 to 15 years	58.24%	54.26%	0.4529	0.05	3.8414	0.5634
16 to 20 years	57.48%	64.47%	0.2322	0.05	3.8414	1.4272
More than 21 years	57.93%	N/A				

Table 4.11

Faculty experience in higher education and student outcomes for MAT 070

Variable	<u>Passing percentages</u>		P-value	Alpha	Critical value	Observed chi-square
	Non-subject	Subject				
2 years or less	52.41%	53.40%	0.7456	0.05	3.8414	0.1052
3 to 5 years	52.35%	52.94%	0.7979	0.05	3.8414	0.0656
6 to 10 years	53.72%	50.00%	0.1237	0.05	3.8414	2.3696
11 to 15 years	52.18%	60.00%	0.1269	0.05	3.8414	2.3297
16 to 20 years	52.32%	55.23%	0.4647	0.05	3.8414	0.5345
More than 21 years	52.65%	48.78%	0.6233	0.05	3.8414	0.2412

Table 4.12

Faculty experience in higher education and student outcomes for MAT 080

Variable	<u>Passing percentages</u>		P-value	Alpha	Critical value	Observed chi-square
	Non-subject	Subject				
2 years or less	43.65%	42.02%	0.7422	0.05	3.8414	0.1082
3 to 5 years	44.32%	37.23%	0.1967	0.05	3.8414	1.6663
6 to 10 years	43.40%	43.35%	0.9901	0.05	3.8414	0.0002
11 to 15 years	42.69%	46.96%	0.3979	0.05	3.8414	0.7145
16 to 20 years	43.17%	N/A				
More than 21 years	43.10%	47.06%	0.5822	0.05	3.8414	0.3027

Instructional experience at the college. There was a broad spectrum of instructional experience in higher education among the developmental mathematics faculty at the college. The years of teaching experience for many of the faculty included extended periods at the college. The categories utilized to group instructional experience at the college, also the number of years of instructional experience in developmental education, were less than two years, three to five years, six to 10 years, 11 to 15 years, and more than 15 years. With five categories analyzed in respect to student outcomes at three instructional levels there were 15 points of comparison. In several of the categories results will be interpreted with caution as the diversity in age, gender and employment status among the faculty was limited. There was only point of comparison in which a student sample of sufficient size was not possible. Faculty with six to ten years of instructional experience at the college taught no sections of MAT 080 during the four year period covered in the study.

There were 10 faculty with two years or less instructional experience at the college. One was a male part time instructor. Two were female full time instructors. Seven were female part time instructors. All faculty age categories were represented in this group which taught 495 MAT 060 students, 627 MAT 070 students and 182 MAT 080 students.

There were six faculty with three to five years of instructional experience at the college. One was a male full time instructor. One was a male part time instructor. Three were female full time instructors. One was a female part time instructor. All age categories for instructors except less than 35 years of age were represented in this group which taught 380 MAT 060 students, 952 MAT 070 students and 347 MAT 080 students.

There were two faculty with six to 10 years of instructional experience at the college. Both were female part time instructors. One was in the 35 to 44 age group and the other in the 55 and older age group. These instructors taught 160 MAT 060 students, 111 MAT 070 students and no MAT 080 students.

There were two faculty with 11 to 15 years of instructional experience at the college. One was a 35 to 44 year old female full time instructor. One was a 55 year old or older female part time instructor. These instructors taught 94 MAT 060 students, 100 MAT 070 students and 115 MAT 080 students. They were the same instructors with 11 to 15 years of experience in the instructional experience in higher education categories.

There were four faculty with 16 years or more of instructional experience at the college. One was a 55 year old or older male full time instructor. One was a 55 year old or older female full time instructor. One was a 45 to 54 year old female part time instructor. The last was a 55 year old or older female part time instructor. These faculty taught 76 MAT 060 students, 213 MAT 070 students and 66 MAT 080 students.

The null hypothesis for faculty instructional experience at the college was a faculty person's cumulative years of instructional experience at the college is independent of student success rates in the developmental mathematics courses taught by that faculty person. This hypothesis was supported in 12 of the 15 points of comparison. Faculty with less than two years of experience at the college had a statistically significant negative relationship with student success rates at the 0.03 level with a p-value of 0.0263 when teaching MAT 060 (Table 4.13). Faculty with three to five years of experience at the college had a statistically significant positive relationship with student success rates at the 0.03 level with a p-value of 0.0247 when teaching MAT 060 (Table 4.13). Faculty

with six to 10 years of experience at the college had a statistically significant negative relationship with student success rates at the 0.01 level with a p-value of 0.0090 when teaching MAT 070 (Table 4.14).

The results for four of the subcategories show uniform patterns in direction of impact. Faculty with two years or less of teaching experience at the college had lower success rates among their students than their peers at all three levels of instruction. Faculty with three to five years of teaching experience at the college had higher success rates among their students than their peers at all three levels of instruction. Faculty with six to 10 years of instructional experience at the college had lower success rates among their students than their peers at both instructional levels at which sufficient sample sizes existed. Faculty with more than 15 years of instructional experience at the college had higher success rates among their students than their peers at all three levels of instruction.

Table 4.13

Faculty experience at the college and student outcomes for MAT 060

Variable	<u>Passing percentages</u>		P-value	Alpha	Critical value	Observed chi-square
	Non-subject	Subject				
2 years or less	60.56%	54.14%	0.0263	0.03	4.7093	4.9350
3 to 5 years	55.76%	62.63%	0.0247	0.03	4.7093	5.0441
6 to 10 years	57.99%	57.50%	0.9068	0.05	3.8414	0.0137
11 to 15 years	58.24%	54.26%	0.4529	0.05	3.8414	0.5634
More than 15 years	57.48%	64.47%	0.2322	0.05	3.8414	1.4272

Table 4.14

Faculty experience at the college and student outcomes for MAT 070

Variable	<u>Passing percentages</u>		P-value	Alpha	Critical value	Observed chi-square
	Non-subject	Subject				
2 years or less	53.56%	50.40%	0.1887	0.05	3.8414	1.7275
3 to 5 years	50.99%	54.31%	0.1387	0.05	3.8414	2.1919
6 to 10 years	53.27%	40.54%	0.0090	0.01	6.6347	6.8213
11 to 15 years	52.18%	60.00%	0.1269	0.05	3.8414	2.3297
More than 15 years	52.40%	53.99%	0.6608	0.05	3.8414	0.1926

Table 4.15

Faculty experience at the college and student outcomes for MAT 080

Variable	<u>Passing percentages</u>		P-value	Alpha	Critical value	Observed chi-square
	Non-subject	Subject				
2 years or less	45.27%	37.91%	0.0843	0.05	3.8414	2.9794
3 to 5 years	42.70%	44.09%	0.7082	0.05	3.8414	0.1401
6 to 10 years	43.38%	N/A				
11 to 15 years	42.69%	46.96%	0.3979	0.05	3.8414	0.7145
More than 15 years	42.86%	48.48%	0.3796	0.05	3.8414	0.7719

Faculty rank. There are five possible faculty statuses at the research site. Part time faculty cannot advance in rank. Part time or adjunct status, while potentially an introductory rank and the only possible status for part time instructors, was considered above as an employment status and was not reconsidered as a rank. To review, the statistical analysis indicated that part time instructors were significantly associated with lower than expected student success rates at all three levels of instruction (Tables 4.2, 4.3, 4.4, 4.16). The introductory and earned ranks for full time faculty are Instructor, Assistant Professor, Associate Professor and Full Professor (RCC Faculty Senate, n.d.). Given four ranks and three levels of instruction, there were 12 possible points of comparison for this construct. However, no Full Professors taught MAT 060 during the four year period in the data set. As a result, the data set allowed 11 points of comparison for faculty rank.

The largest group of faculty in the developmental mathematics faculty pool at the college was part time faculty members. This group of faculty was 62.5% of the total count of 24 persons and shows greater diversity in terms of age and gender than the full time faculty (Table 4.1). This group was considered as an employment status and was not included in the faculty rank comparisons. However, one person from this group was included in the faculty rank analysis. The college has one faculty member who served as a part time faculty person during the course of the study who had held a full time position in the past. She has a long history with the college and had achieved the highest faculty rank possible. Although she was active in an adjunct capacity during the course of the study, she was included in the faculty rank analysis as she held the rank Full Professor. The faculty groups formed by academic rank taught sufficient numbers of students to be

considered representative groups for every possible comparison except Full Professors and MAT 060. No Full Professors taught MAT 060 during the four years of the study.

The faculty with the entry level rank of Instructor were three females. All three were full time faculty. Their ages placed them in three different age categories, the 35 to 44 year old, the 45 to 54 year old and the 55 and over age categories. One had two years or less instructional experience in higher education while the other two had three to five years of experience. Two of the three had gotten all their higher education instructional experience at the college which served as the research site. One of the persons with three to five years experience in higher education had two or less years of experience at the college. The Instructors taught 245 students in MAT 060 sections, 365 students in MAT 070 sections and 128 students in MAT 080 sections.

The faculty who had earned the first advancement in rank to Assistant Professor were two females and a male. All were full time faculty. The women were in the 35 to 44 age category while the man was in the 45 to 54 age category. All three had three to five years of experience at the institution and six to 10 years of instructional experience in higher education. The Assistant Professor group taught 160 students in MAT 060 sections, 507 students in MAT 070 sections and 316 students in MAT 080 sections.

There were two full time faculty members with the rank Associate Professor. They were both female. One was in the 35 to 44 year old age group and the other was in the 55 year of age and older group. The younger faculty person had 11 to 15 years of experience at the college and in higher education instruction. The older faculty person over 15 years of experience at the college and 16 to 20 years of experience in higher

education instruction. The Associate Professor group taught 135 students in MAT 060 sections, 231 students in MAT 070 sections and 58 students in MAT 080 sections.

There were two faculty who held the highest possible academic rank, Full Professor. One was a male, full time faculty person. The other was a female, part time faculty person. Both were in the 55 years of age and older category. Both had instructional experience in higher education that exceeded 21 years all of which had occurred at the research site. The Full Professor group taught no students in MAT 060 sections, 41 MAT 070 students and 51 students in MAT 080 sections.

The null hypothesis associated with the 11 possible points of comparison for faculty rank was: A faculty person's rank at the college is independent of student success rates in the developmental mathematics courses taught by that faculty person. The null hypothesis was supported in six of the 11 points of comparison. However, in MAT 060 Assistant Professors were associated with higher than expected student success rates at an α level of 0.05 with a p-value of 0.0345 (Table 4.16). In MAT 070, Instructors were associated with higher than expected student success rates and Assistant Professors with lower than expected student success rates (Table 4.16). The Instructors' positive result was significant at a 0.02 level with a p-value of 0.0169 (Table 4.16). The Assistant Professors' negative result was significant at a 0.01 level with a p-value of 0.0054 (Table 4.16). At the MAT 080 level, Associate Professors were associated with higher than expected student success levels (Table 4.16). Associate Professors teaching MAT 080 were associated with higher than expected student success rates at a 0.03 level with a p-value of 0.0240 (Table 4.16).

The results of the faculty rank analysis reveal a pattern. This pattern is clearly illustrated in the results achieved by students in course sections taught by Assistant Professor rank faculty. The relationships of faculty rank and student success rates were statistically significant for all three levels of instruction for Assistant Professors (Table 4.16). However, the direction of the influence on student success rates was different in MAT 060 than it was in MAT 070 and 080. This relationship also existed at the Instructor rank and Associate Professor rank (Table 4.16).

Table 4.16

Faculty rank and student outcomes

Variable	<u>Passing percentages</u>		P-value	Alpha	Critical value	Observed chi-square
	Non-subject	Subject				
MAT 060 Essential Mathematics						
Part time	61.30%	55.19%	0.0327	0.04	4.2179	4.5623
Instructor	63.05%	59.18%	0.3583	0.05	3.8414	0.8437
Assistant professor	58.42%	68.13%	0.0345	0.05	3.8414	4.4691
Associate professor	62.72%	57.04%	0.2407	0.05	3.8414	1.3764
Full professor	57.93%	N/A				
MAT 070 Introductory Algebra						
Part time	56.57%	47.67%	0.0001	0.01	6.6349	15.7621
Instructor	54.07%	61.64%	0.0169	0.02	5.4119	5.7096
Assistant professor	60.40%	52.07%	0.0054	0.01	6.6349	7.7401
Associate professor	56.08%	58.44%	0.5193	0.05	3.8414	0.4153
Full professor	56.87%	48.78%	0.3049	0.05	3.8414	1.0525
MAT 080 Intermediate Algebra						
Part time	46.38%	33.92%	0.0042	0.01	6.6349	8.2109
Instructor	46.23%	46.88%	0.8981	0.05	3.8414	0.0164
Assistant professor	50.67%	43.35%	0.0934	0.05	3.8414	2.8155
Associate professor	44.70%	60.34%	0.0240	0.03	4.7093	5.0950
Full professor	46.31%	47.06%	0.9189	0.05	3.8414	0.0104

General Patterns in Results

With fifteen hypotheses tested, there is a potential for general patterns to be recognized in the results. To facilitate comparisons necessary to discern general patterns, a cross tabulation chart of the outcomes was constructed.

Tables 4.17, 4.18 and 4.19 contain the results of the cross tabulation. The difference between the passing percentages for students for each variable or subcategory of a variable is included at each level of instruction. The differences are summarized as the subjects being associated with a higher student passing percentage than expected (\wedge), a lower percentage than expected (\vee) or not applicable (N/A) as data was not available or the sample was too small to be representative.

Table 4.17 lists all the variables and subcategories of variables which showed a uniform pattern. There were only two possibilities. The subject group was associated with higher student success rates than expected at all three levels of instruction or was associated with lower success rates than expected at all three levels. Both cases exist on Table 4.17.

Table 4.18 lists all the variables and subcategories of variables which were associated with changes in direction for student success rates across the three levels of instruction that displayed a one versus two pattern. For example, the subject group is associated with higher success rates than expected in MAT 060 and 070 but lower than expected in 080. Table 4.19 lists all the remaining variables and subcategories.

Table 4.17

Directional relationship for all variables and subcategories showing a uniform pattern with statistically significant relationships marked

Variable or subcategory	MAT 060	MAT 070	MAT 080
Male	V	V	V*
Female	∧	∧	∧*
Full time	∧*	∧*	∧*
Part time	V*	V*	V*
County resident	V	V	V
CC graduate	V	V	N/A
Grad. = Education	V	V	V*
Grad. major = Algebra	V	V	V
Grad. major = Calculus	∧	∧	N/A
Grad. major = Computer	V*	V*	V*
Grad, major = Statistics	∧*	∧	∧
No grad. math	V	V	V
1 to 18 hrs grad. math	V	V	V
37 or more hrs grad. math	∧	∧*	∧
16 to 20 years in HE	∧	∧	N/A
2 years or less at college	V*	V	V
3 to 5 years at college	∧*	∧	∧
6 to 10 years at college	V*	V*	N/A
More than 15 years at college	∧	∧	∧

* = Statistically significant at $\alpha = 0.05$

Table 4.18

Directional relationships for all variables and subcategories with a separation between one instructional level and two others, statistically significant relationships marked

Variable or subcategory	MAT 060	MAT 070	MAT 080
Separation between MAT 060 and MAT 070/080			
Age 35-44	∨	∧	∧
Age 45-54	∧	∨	∨*
6 to 10 years in HE	∧*	∨	∨
11 to 15 years at college	∨	∧	∧
Instructor	∨	∧*	∧
Assistant professor	∧*	∨*	∨
Associate professor	∨	∧	∧*
Separation between MAT 080 and MAT 060/070			
Secondary experience	∧	∧	∨
Simultaneous secondary involvement	∧	∧	∨
B.S. only	∧	∧	∨
B.S. Education	∧	∧	∨

* = Statistically significant at $\alpha = 0.05$

Table 4.19

Directional relationships for all variables and subcategories with an alternating pattern with statistically significant relationships marked

Variable or subcategory	MAT 060	MAT 070	MAT 080
Age 55+	∨	∧	∨
19 to 36 hrs grad. Math	∧	∨	∧
2 years or less in HE	∨	∧	∨
3 to 5 years in HE	∨*	∧	∨
11 to 15 years in HE	∨	∧	∨
More than 21 years in HE	N/A	∨	∧
Full professor	N/A	∨	∧

* = Statistically significant at $\alpha = 0.05$

Table 4.17 lists 21 variables or subcategories associated with uniform influence on student success rates. Tables 4.18 and 4.19 list 19 variables or subcategories. 52.5% of the variables or subcategories exhibited a uniform influence on student success rates at the college which served as the research site across the four years considered.

Table 4.18 lists 12 variables or subcategories associated with success rates that were similar for two sequential levels of instruction but the opposite in the third. This represents 30% of the variables or subcategories considered in the study.

Table 4.19 lists the remaining nine variables or subcategories. Five or 12.5% of the topics considered had a the same success rate pattern in MAT 060 and MAT 080 but not in MAT 070.

Summary

In the statistical analysis of the data set 114 points of comparison between faculty characteristics and student success rates were computed. Of these, 25 returned statistically significant results. The correspondence of these results to the literature, the importance of the results for the local program and the importance of the results for rural community colleges will be discussed in the final chapter of this dissertation.

CHAPTER 5 - SUMMARY AND DISCUSSION

This dissertation addresses a concern common to all regions of the United States, all institutions of higher education and to the future of the American work force, student success rates in developmental mathematics. In this chapter, the problem will be restated, a brief review of the methodology will be provided, the results of the investigation will be summarized and discussed, implications of the results for practice will be noted and recommendations for further research will be made.

Problem Statement

The research topic investigated in the study was the association of instructor characteristics and student outcomes in community college developmental mathematics.

Statement of Problem

The research problem can be stated in the following manner: The purpose of this ex post facto study was to investigate the association of selected personal traits and experiential characteristics of faculty with student success rate in developmental mathematics at a rural North Carolina community college (Creswell, 1994, p. 64).

Independent Variables

The personal and experiential characteristics of faculty which will served as independent variables are: faculty age, gender, employment status (full time or part time), residence in the county served by the college, instructional experience in secondary education, present employment in secondary education, graduation from a community college, possession of only a bachelor's degree, possession of an undergraduate degree in Education, possession of an advanced degree in Education, predominant type of

mathematics studied in graduate school (Hathaway, 1983), hours of graduate mathematics study, years of instructional experience in higher education, years of instructional experience at the college and academic rank. Each of these variables was investigated in regard to its effect on student completion rate in semester length courses in developmental mathematics at a rural community college.

Dependent Variable

The dependent variable in the study was student success rate in developmental mathematics. Success was defined as receiving a passing grade in the course, a C or better. A lack of success was defined as receiving a non-passing grade or withdrawing from the course.

Review of the Methodology

The study was conducted as an ex post facto investigation. All data related to student success were historic and gathered from the academic records of a rural, North Carolina community college. All data related to independent variables were gathered from the personnel files maintained by the college. These methods guaranteed that the accuracy of the data had been verified. Access to this information was obtained through a request for the release of public information. The data set for the study was gathered at one college.

The study was planned and conducted based upon a model devised by Alexander Astin. Astin's model, which has three elements, was designed for use by researchers in higher education (Astin, 1968). Astin states "The...model was developed...to study naturally occurring variations in environmental conditions and to approximate the methodological benefits of true experiments by means of...statistical analyses" (1991, p.

28). The three elements of the model are input, environment, and output (Astin, 1968; 1976; 1991).

In Astin's model, input is "potentials for growth and learning that students bring with them to college" (Astin, 1976, p. 11). Students who are required to take developmental mathematics have arrived at the institution with a measured "level of talent...previously developed" (Zhao, 1999, p. 4), an input.

Output "refers to those aspects of the student's development that the college either attempts to or does influence...fairly immediate outcomes that can be operationalized" (Astin, 1976, p. 11). In the study under discussion, student final grade in one of three levels of developmental mathematics was the output considered.

"Input and output data by themselves...are of limited usefulness. What we need in addition is information about the students' educational environment and experience" (Astin, 1991, p. 18). Astin's term for "the students' educational environment and experience" is environment. He uses this term to describe "any characteristic of the college that constitutes a potential stimulus for the student, i.e., that is capable of changing the student's sensory input" (1968, p. 3). Incorporating these variables with a consideration of input and outcomes is important as "by focusing on the observable stimulus properties of the environment, we can identify some of the specific environmental variables that affect the student's development" (Astin, 1968, p. 5). The environmental variables investigated as independent variables in this study were the personal traits and experiential characteristics of developmental mathematics faculty listed above.

Astin's model shows particular concern for limiting the influence of confounding variables. The study was designed to "adjust for...input differences in order to get a less biased estimate of the comparative effects of different environment [factors] on outputs" (Astin, 1991, p. 19). "Unless the effects can be accounted for by identifiable institutional characteristics, we cannot arrive at the generalizations needed for improving educational theory and for formulating sound educational policy" (Astin, 1968, p. 2). In the study described, the sampling method adjusted for input differences. A large purposive sample (Ary, Jacobs, Razavieh & Sorensen, 2006) of students, 3,918 total, was employed. This represented all students participating in classroom based developmental mathematics courses taught by the mathematics department between fall of 2003 and spring of 2007. This sample was divided into three groups based upon standardized testing scores. These groups correspond to the three developmental mathematics courses taught at the college. The size and inclusive nature of the sample made it representative. The ability to sort the sample by entry level skill in mathematics provided the necessary controls for variance in entry level skill, a potential influencer of the dependent variable.

The statistical analysis of the data included chi-square of independence calculations and the calculation of p-values. These were performed using the Excel software package.

Discussion of Results

Fifteen variables, many with multiple components, were investigated. Each concerned the relationship between a faculty trait or characteristic and student success rates in the developmental mathematics classes taught at a rural North Carolina community college. The statistical analysis of the data yielded results which have been

presented in the previous chapter. These results will be discussed in the order personal traits, educational experience and higher education instructional experience.

The results will be discussed in light of the literature. As was noted in the second chapter of this dissertation, there are a number of dissertations which addressed topics relevant to the study being described. These dissertations consider developmental educators or the influence of the characteristics of developmental educators. However, the periodical literature of the field of developmental mathematics has very few articles with content relevant to the present study and, to the best of the author's knowledge, the general literature of developmental education has none. As a result, the study being described was exploratory in nature. Constructs with little or no evidentiary presence in the literature of developmental education were considered.

The literature of higher education has a great many publications with content related to the present study. However, this literature has little utility for interpreting the results of the present study. It does not describe faculty interaction with underprepared students in pre-college level courses, the focus of the present research project. The material from the literature which is relevant to the present investigation, from dissertations and the periodical literature, will be cited in the discussion which follows.

In addition to relating the results of the present study to the literature, other elements will be presented in the discussion which follows. Insights provided by the present study will be noted. Links to theory, supporting or "disconfirming evidence" (Glatthorn & Joyner, 2005, p. 209), will be noted. Following the discussion, implications for practice and recommendations for further research will be offered.

General Results

An overview of the results for all the variables tested reveals a number of patterns. The first supports the basic premise of the study. The second illustrates that the relationships found are complex and, in some instances, counterintuitive. The third supports the distinctive nature of the three courses. The fourth suggests a threshold for positive impact on student success for the number of graduate hours of mathematics completed by faculty members. The final general observation is the presence of three variables or subcategories of variables which had statistically significant relationships with student success at all three levels of instruction and two others with statistically significant relationships with student success at two levels of instruction.

The personal traits and experiential characteristics of faculty are associated with student success rates in developmental mathematics at the college. Twenty-five of the 114 points of comparison calculated yielded statistically significant results at an $\alpha = 0.05$ level or higher. Twenty-one of the groups of faculty formed around variables or subcategories of variables investigated were found to have relationships to student success rates which were uniformly negative or positive across all three levels of instruction. That 21 separate categories would all exhibit the same pattern has a high statistical improbability. These two patterns support the basic premise of the study, personal traits and experiential characteristics of faculty are related to student success in developmental mathematics at the college.

The relationship between faculty characteristics and student success in developmental mathematics at the college is complex. No variable had a completely uniform association with student outcomes. The 21 which exhibited uniformly positive or

negative associations with student outcomes did so in varying degrees at each level of instruction. 19 variables or subcategories of variables inverted relationships with student success from one level of instruction to the next. The three variables with statistically significant results at all three levels of instruction varied in the strength of the relationship from one instructional level to the next. The results of the statistical analysis support the conclusion that the relationship of faculty characteristics to student success in developmental mathematics is complex.

There were several variables that yielded results which seemed counterintuitive. Examples are instructional experience in secondary education, faculty who graduated from a community college, holding an undergraduate degree in Education and possession of a graduate degree in Education. Each of these variables had no statistically significant relationship with student success rates or was statistically associated in at least one level of instruction with lower than expected student success rates.

The student success rates analyzed portray distinctions between the courses MAT 060 Essential Mathematics (RCC, 2007), MAT 070 Introductory Algebra (RCC, 2007) and MAT 080 Intermediate Algebra (RCC, 2007) and the possibility of interaction between faculty traits and course content specific factors (Merisotis & Phipps, 2000, p. 82). The distinction in course content is commonly described by the college mathematics faculty and is evident in the course names. There were 19 variables or subcategories of variables for which student passing rates exhibited different directions of influence in at least two of the course types. Eight had inverse relationships between success rates in MAT 060 and those in MAT 070 and 080. Four had inverse relationships between success rates in MAT 080 and those in MAT 060 and 070. Seven had success rates which

inverted and reverted moving across the three levels of instruction. These variations seen in student outcomes for the same groups of faculty across four years of data support the distinctive nature of the three courses and possibility that some of the content distinctions may interact with other factors to influence student outcomes. The research of Barker supports the second concept. His regression analysis found “a path to academic achievement from an interaction between the institutional environment and instruction...variables” (1994, p. xi).

Graduate hours of mathematics completed exhibited a threshold level in the results of the study. This pattern suggests a threshold of graduate hours of credit in mathematics completed by faculty to be associated with increased student success rates. This result and the clear implications for colleges are discussed below.

The final general observation is that three variables or subcategories of variables had statistically significant relationships with student success at all three levels of instruction and two others had statistically significant relationships with student success at two levels of instruction. Both employment statuses and one subcategory of the variable predominant type of mathematics studied in graduate school had significant relationships with student success rates in developmental mathematics at the college at all three levels of instruction. Assistant professors and faculty with six to ten years of instructional experience at the college which served as the research site had significant relationships with student success rates in developmental mathematics at two levels of instruction. Each of these relationships is discussed below.

Some of the results were unexpected and exhibited seemingly erratic patterns which the researcher could not explain. These may indicate the presence of factors not

included in this study which impacted the result (Penny & White, 1998). The researcher has noted these instances in the discussion which follows.

Personal Traits of Faculty

The personal traits of faculty included in the study were age, gender, employment status and residence in the county served by the college.

Faculty Age

Faculty age was associated with student success rates in a statistically significant manner at the MAT 080 level. However, this was not the case for all the faculty age categories. It occurred for faculty 45 to 54 years of age and was a negative relationship.

The age categories utilized to classify faculty, under 35 years of age, 35 to 44 years of age, 45 to 54 years of age and 55 years of age or older, yielded three groups which taught sufficient numbers of students to be considered representative of the student sample and two with sufficient diversity in terms of gender and employment status to be representative of the college mathematics faculty.

The developmental mathematics faculty at the college included only one person under the age of 35. This faculty member taught only 16 students and statistical analysis was not completed for this category limiting the number of age categories with sufficient samples to three. The three other age categories included student samples that were large enough to be representative. However, the eight 35 to 44 year old faculty members who were split evenly between full time and part time status were all females. The results of this study in respect to faculty gender indicate that a grouping for a subcategory of another variable which includes only female faculty would be influenced toward positive relationships by this characteristic, especially at the MAT 080 level. However, this

characteristic did not result in higher than expected student success at all three levels of instruction for the 35 to 44 year old faculty or a statistically significant relationship with student success.

Only one statistically significant result was found for the variable faculty age. 45 to 54 year old instructors had a statistically significant relationship with lower than expected student success in MAT 080 at an α of .02 and a p-value of 0.0111 (Table 4.4). These results expand the knowledge base regarding the influence of faculty characteristics in developmental mathematics and, as a result, higher education.

The work of other researchers has included investigating the impact of faculty age in developmental mathematics. This research has considered its impact on faculty attitude and student outcomes. Both Gross (1999) and Morris (2004) investigated the attitudes of faculty toward developmental education. Gross found that “the overall attitudes of faculty...teaching in departments offering developmental courses were negative” (1999, p. ii) and that mathematics faculty had the least positive attitudes among faculty in the academic disciplines investigated although these relationships were not statistically significant. Morris found a positive correlation between the attitude of developmental mathematics faculty toward developmental education and student success (2004). In respect to student success, Penny found no significant relationship between faculty age and student success in their last developmental mathematics at three southern universities (1996). Yet the present study yielded a strong statistically significant relationship. This appears to represent the understanding of the construct in the general literature of higher education which includes studies linking faculty age to instructional activity and attitude. Examples of the constructs with this relationship in the literature of higher education

include teaching goals (Fox, 1997), declines in variety of teaching behavior (Horner, 1989) and preference for teaching (Colbeck, 1992). Hence, the results of the present study expand the knowledge base in developmental education and its superset, higher education by demonstrating a case in which faculty age was significantly related to student success rates in developmental education.

The result found for the 45 to 54 year old instructors should be considered to be uninfluenced by the gender and employment status of the group as diversity in regard to these factors similar to that of the entire mathematics faculty was exhibited. However, this result is unprecedented in the literature of developmental education. It does not parallel the findings of previous studies and it was found at a rural community college, a research site not previously included in investigations of this construct. The result may be related to an unidentified characteristic of the members of the group, another local factor, or other situational factors.

The statistically significant relationship of 45 to 54 year old faculty with student success rates in intermediate Algebra should not be generalization to other rural community colleges. Replication of the present study would be necessary for the results found to be employed in generalization to other institutions as they are unprecedented in the literature of developmental mathematics and developmental education. However, the testimony of the general literature of higher education lends support to the credibility of these results (Colbeck, 1992; Fox, 1997; Horner, Murray & Rushton, 1989).

Faculty Gender

Four of the 24 faculty members in the study were male. There were 20 female faculty included in the study. Both faculty groups were sufficiently similar to the

characteristics of the entire faculty in respect to employment status and age to be representative of the college mathematics faculty. Both groups had student samples that were large enough to be representative.

A statistically significant relationship was found between instructor's gender and student success rates at the upper level of instruction. In MAT 080, the association was significant at an $\alpha = 0.04$ level with a p-value of 0.0318 (Table 4.4). The data set includes a second characteristic. At every level of instruction, male faculty were associated with lower than expected student success rates and females with higher than expected success rates (Tables 4.2, 4.3, 4.4). At the MAT 070 level, the association was just outside the level of significance defined for the present study with a p-value of 0.0549 (Table 4.3). The student success rates across the four years of the study were 54.55% for male instructors versus 58.19% for female instructors in MAT 060, 48.19% for male instructors versus 53.62% for female instructors in MAT 070 and 32.97% for male instructors versus 44.91% for female instructors in MAT 080 (Tables 4.2, 4.3, 4.4).

The results extend the understanding of the impact of faculty gender on student success in developmental mathematics. Hewitt's dissertation (2001) found no relationship between faculty gender and student success rate in developmental mathematics at an urban community college however, she considered the relationship of faculty gender with an outcome very different than the present study and which included the potential for multiple intervening variables. Gross' study considered faculty attitudes and found that female faculty in the University System of Maryland had "more positive attitudes....toward developmental education" (1999, p. iv) than males. Penny and White found an association in a university setting in curricular mathematics for former

developmental mathematics students stating that “the variable of male teachers...had a weak, negative correlation with performance in college algebra” (1998, p. 5). The present study considered the same construct as the previous studies but sought to understand its impact on single semester success rates in developmental education a rural community college expanding the scope of the literature.

That a significant relationship between faculty gender and student success rate was found at only one level of instruction does not detract from the veracity of the result. The student passing rates of female faculty were higher than those of male faculty in MAT 060, nearly 4 percentage points higher, and nearly significant in MAT 070. Information from a separate ex post facto study completed by the author of this document at the college which served as the research site for this dissertation provides a possible explanation for the MAT 060 result in respect to faculty gender. This study was distributed within the college in early 2008.

The study which offers an explanation for the results above considered the characteristics of all students applying to the college in the calendar year 2006, their enrollment patterns and their success rates. As a result, the information regarding developmental mathematics from the 2008 study describes a subset of the sample for the present study, a cluster sample (Ary, Jacobs, Razavieh & Sorensen, 2006). As the 2008 study included all students applying in the year 2006, it can be considered representative. As it represents all new students enrolling in developmental studies during one year of the present investigation, 515 students, it can be said to represent the sample of the present investigation. The student population in MAT 060 at the college included an overrepresentation of Black students, 65.4% of Black enrollees compared to 26.5% of

White enrollees (Preuss, 2008b). In addition, it was found that the passing rates for Blacks enrolled in MAT 060 was 40.40% while that for Whites was 63.70% (Preuss, 2008b). These results are similar to those reported by McDonald (1988) in a national survey and those reported by Walker and Plata at a “regional university” (2000, p. 24) and Zhao at a community college (1999). The lack of significance at the MAT 060 instructional level for the variable faculty gender may have been influenced by these particulars of the MAT 060 population although the influence would have been limited. Less than one third of all the new students entering MAT 060 in 2006 were Black. A downward effect caused by the overrepresentation and underperformance of Blacks in MAT 060, a characteristic of the sample, may have sufficiently dampened the MAT 060 passing frequency for female faculty to have kept them from being statistically significant.

The outcome of the present study in respect to faculty gender extends the understanding of the impact of the construct in developmental mathematics instruction to rural community colleges and to single semester success by students. The work of Gross (1999) and Penny and White (1998) parallel or corroborate the result of the present study. While replication of the results of the present study would strengthen the case for the reliability and validity of the result, the presence of a quantitative study employing a large ex post facto sample with similar results for former developmental mathematics students (Penny & White, 1998) and a second study surveying 120 faculty which provides corroborating evidence (Gross, 1999) is important. The argument that faculty gender impacts student success in developmental mathematics has an increasingly strong base of support due in part to the present study.

Faculty Employment Status

Employment status is a second faculty characteristic which research in developmental education supports as a significant influencer of student success rates (Hewitt, 2001; Penny, 1996; Wheland, Konet, Butler, 2003). In the present study it was found to have a statistically significant relationship to student success rates at all levels of instruction.

The research site faculty included more females than the average American community college faculty, 78% of the full time faculty and 88% of the part time faculty, but was not exclusively female in either category (Table 4.1). Although weighted more heavily female than the average American community college faculty, the employment status groupings were sufficiently similar to the characteristics of the entire faculty in respect to gender and age to be representative. Faculty of each employment status taught large numbers of students with the result that the student samples associated with each group were large enough to be representative.

At all levels of instruction, full time faculty status was significantly associated with higher than expected student outcomes. These results occurred at an α of 0.04 with a p-value of 0.0327 in MAT 060 (Table 4.2), at $\alpha = 0.01$ with a p-value of 0.0001 in MAT 070 (Table 4.3) and at $\alpha = 0.01$ with a p-value of 0.0042 in MAT 080 (Table 4.4). Part time faculty status was significantly associated with lower than expected student outcomes at the same values as the chi-square calculations compared observed values for both full time and part time faculty with expected values.

Faculty employment status is a construct about which a reasonable number of findings have already been reported in the literature of developmental mathematics (Fike,

2005; Hewitt, 2001; Penny, 1996; Wheland, Konet, Butler, 2003). Hewitt's dissertation, which addresses developmental mathematics and the significance of faculty employment status in it, includes a lengthy description of studies regarding faculty employment status between 1979 and 1999 (2001). None of the studies cited focused on developmental education settings (Hewitt, 2001). However, studies considering this subject in developmental education have been completed, Hewitt's dissertation being one.

Fike found that faculty employment status did not impact student final grade in one semester developmental mathematics courses (Intermediate Algebra) at a community college, Amarillo College, and that they did not impact course completion rates (2005, pp. 99-100). Penny found that part time employment status was positively related to student success in "the last developmental mathematics course" (1996, p. 68) at three southern universities. Hewitt's research indicated no relationship between developmental faculty employment status and "passing rates of post-developmental college-level mathematics students" (2001, p. v) at an urban community college in the southwest United States. Wheland, Konet and Butler investigated student success in intermediate algebra at a university and compared the results of adjunct faculty to those of graduate teaching assistants (2003). No "particular difference between the mean test scores" (Wheland, Konet, Butler, 2003, p. 20) was found. The published research which is most similar to the present study is the work of Fike and Penny. That Fike's and Penny's research yielded contradictory results when addressing the same or similar course levels and defining one semester success in the same manner as the present study indicates the importance of the present investigation, the potential complexity of the relationships being described and the need for caution when seeking to generalize from local studies.

The results of the present study contradict those published by both Fike and Penny. Strong statistically significant relationships, $\alpha = 0.04$, 0.01 and 0.01, were found between employment status and student success rates, contradicting Fike, and those relationships included higher than expected success for the students of full time faculty and lower than expected for part time faculty at all three levels of instruction, contradicting Penny. Together the studies suggest that an understanding of the relationship of faculty employment status and student success rates in one semester courses is, at best, unresolved for developmental mathematics and that it may be site specific. There are a great many documented site specific influences on faculty including local faculty culture (Colbeck, 1992; Dooris & Fairweather, 1994; Leidig, 1996; Toma, 1997), instructional colleagues (Leidig, 1996; Matney, 2001; Peters, 1996), department chairs (Leidig, 1996), course schedule (Einarson, 2001; La Nasa, 2001) and volume of students (Einarson, 2001), institutional structure (Gotsis, 1996; Leidig, 1996; Webb, 2002), professional development (Davis, 2003; La Nasa, 2001; Matney, 2001), student feedback (La Nasa, 2001; Peters, 1996; Ray, 1999; Wu, 1993) and faculty perceptions of their institution (Matney, 2001). In respect to developmental mathematics faculty, Klein's 1996 dissertation project reported "significant relationships...among teaching efficacy, teacher behaviors, and the work environment" (p. iv). Given this partial list, that the relationship of faculty employment status to student success rates in developmental mathematics could be site specific is not surprising.

The present study has advanced the knowledge regarding the impact of faculty employment status on student success in developmental mathematics. It has demonstrated relationships dissimilar to those currently reported and done this in a different setting

than other research, Penny's research occurred at a three universities and Fike's was done at an urban community college. This indicates that the understanding of the construct faculty employment status and its relationship to student success rates is unresolved and may be specific to the type of institution or the site itself.

County Resident

The personnel records of the college included the home addresses of the faculty members. Seventeen of the faculty chose to reside in the county served by the college while seven chose to reside outside the county served. The faculty groups "county residents" and "residents of other counties" exhibited sufficient similarity to the entire faculty in respect to age, gender and employment status to limit the impact of these characteristics in the calculations performed and the student samples associated with the groups were large enough to be representative.

The college unofficially encourages employees to live in the county served. The intention is for them to become integrated in the local community as a means of facilitating their work at the college and acting as ambassadors for the college. That persons who reside in the county who are among the top 10% in the county in educational attainment and are integrated into the social, political, religious, and education fabric of the county would have a greater affinity with college students from the county seems logical. However, this theory was not supported by the investigation.

Students taught by faculty residing in the county exhibited lower than expected success rates at all three levels of instruction. However, none of the relationships were significant at the $\alpha = 0.05$ level. That this group would not be associated with higher than

expected student success and produced uniformly lower success rates than faculty residing outside the county seems counterintuitive.

The literature of developmental mathematics and developmental education has no considerations of this construct. None were found in the literature of higher education. A search on Ebscohost of all the accessible databases using the search terms “faculty,” “college,” “county,” “resident,” and synonyms of these terms with no restriction in respect to date or publication yielded no literature addressing the impact of residence in the county served on college faculty and their responsibilities. The same was true for a search done on Dissertation Abstracts International. The present study is one of the first, if not the first, to consider this construct.

A possible explanation for the results found arises when one considers the character of the county and the reasons faculty might choose to live in the county. The “Site and Means of Access” section of the methodology chapter of this dissertation established that the county served by the college is rural, characterized by low socio-economic status, low educational attainment and limited employment opportunities. The historic cultural values and practices of the region serve to perpetuate these characteristics (Heath, 1983). Given these characteristics a person with a master’s degree, which had to be obtained outside the county, who chooses to live in the county has likely made a residence decision based on economics and convenience or personal preference.

Housing is cheaper in the county than in the more populated county to the south and transportation costs for commuting to work are lower for persons residing near the college. These are the primary economic advantages for faculty associated with living in the county served by the college. A second likely reason for county residence is a

preference for a rural environment and a social and cultural setting like that of the county served. Both circumstances could contribute to the pattern seen in the results of the investigation for “county resident” faculty.

Persons comfortable in and accepting of the local culture would tend to be accepting of low academic achievement in the population and the low value assigned to education in the regional culture (Heath, 1983). Faculty who chose to save money by living in the county but who may not accept all or the predominant values of the local culture are faced with “in-group...out-group” (Brewer, 2007, p. 728) norm reinforcement. The clash between their values and those of the persons around them perpetuates and strengthens distinctions drawn between themselves, their academic colleagues and the large pool of “others” who live around them and perpetuates and strengthens any prejudices formed (Brewer, 2007). The potential result is that both groups are accepting of and possibly expectant of low academic achievement by students from the county. That such an attitude could impact student outcomes is supported in the literature of developmental education.

Both Gross (1999) and Morris (2004) investigated the attitudes of faculty toward developmental education. Gross found that “the overall attitudes of faculty...teaching in departments offering developmental courses were negative” (1999, p. ii) and that mathematics faculty had the least positive attitudes among faculty in the academic disciplines investigated. Morris found a positive correlation between the attitude of developmental mathematics faculty toward developmental education and student success (2004). The combination of these two lines of investigation, conducted with developmental educators, serve as significant support for the argument above.

While the line of reasoning above is not the only possible explanation for the results found in respect to the variable county resident, it can explain a counterintuitive set of results. As in every circumstance in which MAT 060 results were lower than expected, the racial composition and race related student success rates at this level of instruction could be an intervening variable influencing the outcomes of the chi-square calculations. However, it is less likely to have biased the overall results in the present case as the passing percentages for the variable county resident were lower than expected at all three levels of instruction. An additional factor to consider is that the length of residence in the county was not determined and controlled in the data set. However, it is unlikely this would have served as a confounding variable related to county residence as none of the 17 persons residing in the county were new county residence, there was a variety of periods of residence and a number of the persons included in the resident group had been county residents for extended periods.

Given the discussion above, the results found are an initial study of the potential influence of county residence by faculty on student outcomes. They are unprecedented and could have been influenced at one point by a characteristic of the sample population. As a result, they should be considered circumstances which existed in the local setting investigated until further research is available.

Secondary Education Experience

Nineteen of the developmental mathematics faculty had experience in secondary education. There were five faculty without secondary teaching experience. Both groups taught large numbers of students. There was sufficient diversity in respect to age, gender and employment status in the faculty groups for them to represent the character of the

entire faculty and limit the impact of age, gender and employment status in the calculations performed. The student samples for each group were large enough to be representative.

There were no statistically significant results for the construct instructional experience in secondary education although the student success rates for persons in this group were higher in MAT 060 and MAT 070 than those of persons outside the group. The lack of statistically significant results for this construct seems counterintuitive and will be discussed below with the result for faculty with simultaneous employment in secondary education and as developmental mathematics instructors at the college.

Simultaneous Employment in Secondary Education

Six of the developmental mathematics faculty held teaching positions in secondary education while serving as instructors at the college. This group was comprised of female, part time instructors. Eighteen of the developmental mathematics faculty were not employed simultaneously in secondary education. Both groups taught large numbers of students. Faculty who are not employed simultaneously in secondary education and at the college exhibited all the age and gender and employment traits found in the collective faculty group. However, the faculty with simultaneous employment lacked diversity in terms of gender and employment status. The student samples associated with the groups were large enough to be representative.

There were no statistically significant results for the construct simultaneous employment in secondary education although the student success rates for persons in this group were higher in MAT 060 and MAT 070 than those of persons outside the group. The lack of diversity in terms of faculty gender and employment status would have

produced opposite and canceling effects on this construct as all the faculty employed simultaneously at the college and in secondary education were females and part time instructors. This is the case as female faculty were associated with higher than expected student success rates in a statistically significant manner while part time faculty were associated with lower than expected student success rates in a statistically significant relationship. There was also a potential depressing influence by the racial composition and race related success rates in MAT 060. However, success rates for both faculty with secondary teaching experience and those employed simultaneously in secondary instruction and college instruction were higher than expected in MAT 060. The lack of statistically significant results for this construct seems counterintuitive like the similar results for the variable instructional experience in secondary education especially when one considers the historic pattern of community colleges hiring secondary educators as faculty (Cohen, 2003, p. 77).

Student performance and expectations of new students is a frequent topic of conversation among faculty and professional staff at the college. Based upon those conversations, the researcher has developed an explanation of the results for the two variables related to instructional experience in secondary education.

One of the general distinctions between a college environment and a high school environment is the pattern of interaction. A second and related distinction is the level of responsibility and autonomy of the student. High schools, especially in the present era of high stakes national and state standardized testing, function, to a large extent, in a stimulus-response pattern of interaction. Students are prepared to respond to specific prompts with appropriate pieces of information and reinforced for compliance. Faculty at

the college frequently comment that entering students ask them to follow this pattern even though it limits the responsibility of the learner to lower level thinking. Collegiate instruction assumes that the student will often operate in a higher order thinking pattern and frequently be involved in analytical, evaluative, or synthesizing tasks. Collegiate instruction also involves less personal contact from the faculty person and little or no monitoring of student activity apart from class sessions. The student has high levels of responsibility and autonomy.

The faculty at the college have been educated at colleges and universities by persons who expected them to operate in higher order thinking and to act autonomously. They see this as the college model, a conception reinforced for the author by conversations with the college faculty in multiple disciplines. The researcher suggests that faculty with secondary teaching experience also recognize the distinction in expectations between college and high school and employ the prescribed pattern in each environment. As the two patterns have different levels of expectation for students in terms of thinking skills and level of responsibility and autonomy, having instructional experience in one setting is of limited value in the second. As the expectations of students in secondary education and higher education diverge, the researcher suggests that it is not an anomaly that instruction from former and current high school instructors did not translate into increased student success rates for developmental mathematics at the college.

Educational Background of Faculty

Community college graduate. Four of the college's developmental mathematics faculty were graduates of a community college, the remaining 20 faculty persons were

not. Both groups exhibited age, gender and employment status patterns that represented the faculty as a whole. However, the student samples associated with the groups were not large enough to be representative at all three levels of instruction. The sample size for faculty who graduated from a community college at the MAT 080 instructional level was too small to be considered representative and statistical analysis was not completed for this level of instruction.

There were no statistically significant results for the faculty who graduated from a community college. The results at the MAT 060 and 070 instructional levels were very likely to have occurred at random as indicated by the p-values of 0.9476 for MAT 060 and 0.9343 for MAT 070. Statistical analysis was not completed for MAT 080 as the sample size small and deemed non-representative.

While one might expect for community college graduates to be the most likely candidates to empathize with current community college students there were no significant results for this construct. It is possible that the community college experiences of the faculty varied dramatically from those of the developmental mathematics students they now teach. To have a one-for-one understanding of the students' situation, faculty members would need to have been under-prepared in an academic discipline at the undergraduate level. It seems unlikely that a person who required mathematics remediation at the start of their college career would persist in the study of mathematics to the extent necessary to become a professor of mathematics. A lack of correspondence between the experience of the faculty person and the current students eliminates any possibility of the faculty person's experience helping them relate to and educate their students and would explain the lack of statistically significant results for this construct.

However, many other factors, time, urban versus rural settings, cultural milieu, etc. could contribute to an explanation of the lack of statistically significant results for the construct community college graduate. These results, unique within the literature of developmental education, should be considered as a demonstrated characteristic in the research setting until confirmed or disaffirmed by further research.

Undergraduate degree only. There were seven developmental mathematics faculty who had completed only a bachelor's degree. The remainder of the faculty, 17 persons, held master's degrees and one doctorate. There was sufficient diversity in respect to age, gender and employment status in the two faculty groups to be representative and the student samples associated with each were large enough to be representative.

There were no statistically significant results found. One pattern apparent in the passing rates of students taught by faculty possessing only a bachelor's degree is that instruction from these persons did not have a uniform impact on student success rates in developmental mathematics at the college as the strength and direction of the results varied from course level to course level. However, the passing rates across the three instructional levels for this construct exhibit the same pattern as those for faculty who possess a bachelor's degree in Education. The results of these two constructs will be discussed below.

Undergraduate degree in secondary education. Eleven faculty included in the study held undergraduate degrees in secondary education. The remaining 13 instructors had not completed an undergraduate degree in Education. The student samples for each group were large enough to be representative. The distribution of gender and age was

sufficient in the two groups. However, a predominance of part time faculty among the undergraduate degree in secondary education group formed, given the results reported above, indicates the potential for employment status to influence the outcome of the calculations. The part time faculty with degrees in secondary education degree taught between two-thirds and three-quarters of the students in this category allowing the potential for a strong influence on the results by this group and the proportion of the student sample they taught.

The chi-square calculation did not yield statistically significant results and the potential impact of the previously noted volume of Black students and the race related passing rates would not have been of sufficient strength to depress the results to the observed level. However, combined with the two thirds majority of faculty in the undergraduate degree in secondary education who were part time instructors it would have been of sufficient strength to impact the result at the MAT 060 level. One pattern apparent in the results for this variable, which should be interpreted with caution in light of the information above regarding MAT 060, is that instruction from faculty persons who possesses an undergraduate degree in secondary education did not have a uniform impact on student success rates in developmental mathematics at the college as the strength and direction of the results varied from course level to course level. A second pattern which should also be interpreted with caution is the passing rates across the three instructional levels for this construct exhibit the same pattern as those for faculty who possess a only a bachelor's degree. That the strength and even the direction of the relationships between the observed frequencies and expected frequencies vary from course level to course level is not unique to this construct and should be regarded as little

other than expected variance for one characteristic in three different settings. However, the duplication of the success rate patterns between the bachelor's degree only and the bachelor's degree in secondary education groups is worthy of further consideration.

The bachelor's degree in secondary education group was not a microcosm of the bachelor's degree only group. Three of the faculty who held only bachelor's degrees had degrees in secondary education, four had undergraduate degrees in other areas. Neither group was a mirror image of the other in respect to age, gender, or employment status. In addition, five of the seven faculty in the bachelor's degree only group had two years or less experience at the college but only three in the bachelor's degree in Education group did and many of the faculty in the bachelor's degree in Education group had extensive instructional experience at the college. The two groups were also different in respect to the percentage of persons included who had instructional experience in secondary education, who were considered North Carolina natives, who were county residents, and in respect to academic rank. The researcher was unable to find a unifying characteristic for these two groups. That two groups of different composition in respect to age, gender, employment status and instructional experience in secondary education and higher education would exhibit the same pattern of passing percentages across the three levels of instruction is unlikely. Three possible explanations exist.

The first of the three possible explanations of the pattern is faculty in these two groups may be united by an unknown variable. Another explanation is that there is a characteristic in the student sample causing the pattern noted. That there is a course content characteristic causing this pattern is the third possible explanation. The first explanation can not be ruled out but seems unlikely given the diversity shown in the other

characteristics. The second explanation also can not be ruled out but is also unlikely as the only pattern found in the 2008 study described above with sufficient strength in numbers to impact the results in the present study occurs in MAT 060 and the inversion of outcomes occurs at the MAT 080 instructional level not the MAT 060 level. The remaining explanation, a course content specific factor, is the most likely explanation. This is important for the faculty at the research site as developmental mathematics instructors teach all three levels of developmental mathematics and curricular mathematics. The possible presence of a course content specific factor influential enough to invert passing rate relationships indicates this practice is unwise. It implies that faculty should be assigned to course levels based upon their ability to produce student success at that level rather than a desire to have each person contribute at each level of instruction.

Further research is required to determine if a course specific characteristic or a characteristic of the student sample contributed to the results found. The results should be treated as a demonstrated local phenomenon and their explanation as a proposed explanation until they are confirmed or disaffirmed.

Graduate degree in Education. Of the 24 mathematics faculty members included in the study, 12 held a master's degrees in Education. One male full time faculty person in this group held both a master's degree and doctorate in Education. There was sufficient diversity in respect to age, gender and employment status in the faculty groups for them to be unbiased and the student samples were large enough to be representative.

There was a statistically significant result at one instructional level. In MAT 080 there was a statistically significant correspondence between holding a graduate degree in Education and having lower than expected student success rates at the $\alpha = 0.04$ level with

a p-value of 0.0357 (Table 4.8). These results stand in contrast with the assumptions behind offering graduate studies in Education and, as such, are counterintuitive.

Graduate studies in Education are offered because they are believed to be efficacious in advancing the ability of teachers to conceptualize and facilitate instruction. The general literature of higher education supports association between graduate discipline studied and conceptualization and facilitation of instruction (Einarson, 2001; Fox, 1997; Schwarze, 1996; Seidman, 2004; Stark, 1990). However, in 1999 Gross found that “professional specialization” (p. ii) and “training in remediation” (p. iii) were unrelated to faculty attitude regarding developmental education. Morris also found instructor attitude and “educational major” were unrelated (2004, p. vi). Since Morris’s study found a correlation between faculty attitude and “student success rates” (2004, p. vi), the situation in developmental mathematics would appear to be different than that in higher education at large, however the higher education studies noted above do not attempt to link all three concepts. They seek to associate academic background with practice but not with student success rates (Einarson, 2001; Fox, 1997; Schwarze, 1996; Seidman, 2004; Stark, 1990). Gross and Morris concentrated on an important factor for determining faculty effectiveness, faculty attitude.

While common wisdom, the assumption behind graduate study programs in Education and the research in higher education support the value of graduate studies in Education for developmental mathematics instructors, the results in this study did not. Kozeracki’s dissertation states regarding developmental English instructors, “The instructors indicate that a substantial gap exists between what they learn in graduate school and what they need to facilitate student learning” (2004, p. xi) in developmental

studies. This may also be the case in developmental mathematics even for graduate degrees in Education. It is a concern similar to that described by Nolan in her dissertation (2005). Nolan's research demonstrated that developmental faculty may have a theoretical understanding of efficacious educational principles and processes but fail to enact them (2005). The work of Morris and Gross is also important as it identifies a critical mediating factor in teacher effectiveness, teacher attitude. Combined with the content of the literature, the results of the present study support the existence of a distinction between knowing and doing in both traditional higher education settings and developmental education settings.

The results of the present investigation, although appearing counterintuitive, are supported by other research. They also demonstrate a critical concern, a lack of positive influence on the outcomes of students who are in developmental studies taught by graduates of master's degree programs in Education. The researcher is unaware of studies that investigate the same construct and its impact on student success in developmental education. This initial set of results indicate an important area of investigation for future researchers but should be treated as a demonstrated local phenomenon until further investigations are conducted.

Predominant type of mathematics studied. Among the developmental mathematics faculty at the college there were four areas of concentration in graduate studies. These were Algebra, Calculus, Computers and Statistics. The faculty who completed only a bachelor's degree were treated as a separate independent variable in this study and were not included as a subcategory of this variable. Twelve faculty studied predominantly Algebra in graduate school. Only two faculty members studied Calculus

as the predominant topic in graduate school. Two faculty studied Statistics in graduate school. One faculty person studied Computers in graduate school. When the faculty was divided into these four categories, three small groups with the potential for impact by characteristics other than that being investigated were formed and some levels of instruction included too few students to be representative. The interpretation of the results includes consideration of these patterns. The literature applicable to this discussion has been described in the “Graduate Degree in Education” section above.

No statistically significant relationships were found for the majors Algebra and Calculus. However, statistically significant relationships with lower than expected student success rates were found for the graduate major Computers at all three levels of instruction. In contrast, the major area of study Statistics had significant correspondence with higher than expected student success rates at the highest level of developmental mathematics instruction.

The only independent variable reported prior to graduate studies in Computers with statistically significant results at all three levels of instruction which also exhibited the same directional relationship at all three levels of instruction was faculty employment status. That the negative relationship between a major in Computers and student success rates had one-tenth of one percent likelihood at the MAT 060 level, seven-tenths of one percent likelihood at the MAT 070 level, and 2.6% likelihood at the MAT 080 level of occurring at random indicates that a very strong relationship exists between a characteristic or combination of characteristics of the single faculty member in this category and student success rates. The results for the single faculty member with a major in Computers were reported because she taught large numbers of students, 130 in MAT

060, 255 in MAT 070 and 63 in MAT 080 and the relationships found were strong. The positive relationship between the two full time faculty with a graduate focus in Statistics and student success rates in MAT 060 is also strong. The likelihood that this relationship would occur by chance was one-half of one percent. In addition, the faculty members who studied Statistics in graduate school were associated with higher than expected student outcomes at every level of developmental mathematics instruction and their MAT 070 result was nearly significant, $p\text{-value} = 0.0524$.

As can be substantiated by the numbers of faculty who pursued the major, 12 of 17 persons, Algebra was the primary graduate field of study among the mathematics faculty. That persons who studied Algebra in graduate school would not be related to student success in introductory and intermediate Algebra courses they taught is surprising. That the same relationship existed for a major in Calculus is not as surprising but is unexpected. Hathaway's and Nolan's research and the commonality of a major in Algebra suggest explanations.

Hathaway included the predominant type of mathematics studied by instructors in her investigation of faculty traits and their relationship to student success on a standardized state mathematics exam following remediation (1983). She found no relationship between the two (Hathaway, 1983). Nolan researched the relationship between the beliefs and practices of developmental English instructors at Prairie Community College in Colorado (2005). Her concern was that there is a difference between the theory of action, which functioned as an "espoused theory" (Nolan, 2005, p. 9), and theory in use, what was enacted in the classroom (Nolan, 2005). Her research revealed that the instructors felt the nature of their students limited their ability to

maintain consistency between their espoused educational theory and enacted theory, believed that students needed to change rather than the instructor, believed that “examination of the relationship between teacher beliefs and practices is beyond the scope of the practitioner” (Nolan, 2005, p. 214), focused on “technique and choice of activities” (Nolan, 2005, p. 214) and expressed they had little opportunity for or institutional support for exchanging ideas with each other (Nolan, 2005). She also found that the majority of the instructors had inconsistency between their espoused theory and theory in use (Nolan, 2005). This information about developmental educators at a community college, if actualized among the mathematics faculty at the research site for the present study, would explain the result for Algebra and Calculus majors. They “talk a good game” but do not actualize their beliefs in the classroom. If one adds Klein’s summarization of arguments made by a variety of authors, that college instructors “continue to teach as they were taught” (1996, p. 2), to Nolan’s research the case proposed is buttressed. It is likely that the persons who majored in Algebra and Calculus understand and espouse excellent instructional theory but that they teach in a traditional lecture and memorization and reproduction pattern. This conclusion matches the presence of a departmentally regulated common curriculum in the mathematics classes and the classroom observations of the author of this dissertation who spent an entire year performing Flanders Interaction Analysis Coding in developmental mathematics classrooms at the college as part of another research project. Instruction is traditional, following patterns that have been in place for 50 years (Miles, 2000), which research in developmental mathematics has found to be unrelated to student “academic achievement”

(Barker, 1994, p. 93). These ideas also relate to the results found for faculty who majored in Computers and Statistics.

Faculty members whose graduate studies focused on Computers and Statistics are faced with accommodating themselves to their instructional setting when teaching essential mathematics, introductory Algebra and intermediate Algebra. This accommodation is necessary as their primary area of specialization is further removed from developmental course content than that of Algebra and Calculus majors. As a result, they cannot rely as heavily upon their personal experience in graduate school as an instructional paradigm. This proves to be advantageous for Statistics majors and their students and disadvantageous for Computer majors and their students.

The differences between the constructs studied in graduate school and subject area of instruction result in an inability on the part of the instructors to rely on their educational experiences as a paradigm for the instruction they provide. This forces the instructors to reflect upon and seek to apply their theory in action. This proved advantageous for Statistics majors, a course of study that is calculation based. It proved disadvantageous for the Computer major as that course of study involved less calculation, numeracy, symbolism and algebra, geometry, functions, discrete mathematics, probability and statistics, and deductive proof (American Mathematical Association of Two-Year Colleges, 1995, p. x) and focused on logic. The result for students of Statistics majors is positive as their instructor has graduate level experience with the skills listed above but must evaluate them and synthesize an approach appropriate for instruction of developmental mathematics, something not required to the same extent of Algebra and

Calculus majors. The result for students of Computers majors is negative as the Computer major had not had the skill set noted above reinforced or developed in graduate studies.

It should be noted that the above line of argumentation includes the results for one instructor who majored in Computers. It is also possible that a personal, relational or unknown characteristic of this person influenced the study results. However, as noted above, the relationships found were very strong and the combined probability that the relationships found could have occurred at random at all three levels of instruction is 1.9×10^{-5} . It should also be noted that both of the faculty who majored in Statistics were female full time faculty persons. Both female instructors and full time faculty were associated with higher than expected student success rates in the present study, these characteristics may have impacted the results found for Statistics majors.

The present study expanded the knowledge of developmental mathematics by identifying statistically significant relationships between the graduate majors Statistics and Computers and student success rates at the college. It has also expanded the knowledge base by demonstrating no significant relationship existed between the graduate majors Algebra and Calculus and student success rates at the college. These results must be confirmed by replication before they can be generalized. They have strong implications for community college personnel directors if substantiated by further research.

Hours of graduate mathematics studied. The developmental mathematics faculty at the college had a variety of experience in graduate education, none up to the possession of a doctorate in Education. Faculty graduate hours earned in mathematics during these studies were classified as none, one to 18 hours, 19 to 36 hours and 37 or more hours.

Eight faculty members had no graduate study in mathematics reported in their personnel file. Seven faculty members had one to 18 hours of graduate mathematics study reported in their personnel files. Six faculty members had completed 19 to 36 graduate hours of credit in mathematics. Three faculty persons had 37 or more hours of graduate study in mathematics.

The subcategory “None” was include for this variable. This represents faculty who had no graduate credit hours in mathematics reported in their personnel file. This group does not have a one-to-one correspondence with the bachelor’s degree only variable previously reported. There were faculty who had initiated a graduate program but had not completed it. These persons were a part of the calculations for the bachelor’s degree only variable but were not included in the “None” subcategory for graduate hours of mathematics studied.

The faculty grouped in the four subcategories of graduate hours in mathematics taught sufficient numbers of students for the samples to be considered representative but some of the groups exhibited limited diversity in respect to faculty age, gender and employment status leaving the potential of impact by these characteristics in the present comparison. The faculty with one to 18 hours of graduate study in mathematics were all female as were the faculty with 37 or more hours of graduate study. The faculty with 19 to 36 hours of graduate mathematics study were 66.67% full time faculty, an inversion of the expected proportion based upon the character of the entire faculty.

Faculty with 37 or more hours of graduate credit in mathematics teaching MAT 070 had statistically significant results. These faculty were associated with higher than expected student success rates at an $\alpha = 0.02$ level with a p-value of 0.0136 (Table 4.9).

A second pattern existed in the information regarding graduate hours of study in mathematics. For faculty within the groups “None” and one to 18 hours the success rates for students were lower than expected at all three instructional levels with this negative relationship approaching statistical significance for faculty without graduate hours in mathematics teaching MAT 080. In the 19 to 36 and 37 or more hours of graduate study in mathematics subcategories the student success rates were higher than expected at all three instructional levels with one exception. In MAT 070 success for the 19 to 36 hours subcategory was one half of one percent lower than expected. Further, faculty with 19 to 36 hours of graduate mathematics showed an association with higher than expected outcomes when teaching MAT 060 at a level approaching statistical significance.

The literature of developmental mathematics includes studies which considered graduate hours (Morris, 2004) as does the general literature of higher education (Einarson, 2001; La Nasa 2001) and literature regarding remediation in secondary education (Hathaway, 1983). However, these studies can provide little insight for the results of the present study. The work of Einarson and La Nasa connects education level to faculty activity outside of remediation settings. Hathaway considered this construct in a remediation setting. Her research included hours of study in mathematics by instructors as an independent variable compared to success rates for high school students on a standardized state mathematics exam following remediation (1983). She found a relationship between the hours of credit earned in mathematics by high school instructors and student outcomes following remediation (Hathaway, 1983). However, this association was in secondary education not a higher education developmental studies setting. The work of Morris, which is specific to developmental mathematics and

included 341 instructors at 32 Texas community colleges, found “no significant differences in the instructors’ attitude scores based on...educational level...or amount of preparation specific to teaching [although]...preparation specific to developmental education” (2004, p. v). The present study has more specific categories than Morris’ study, one more increment in classifying graduate hours than Morris’ study, and considers student outcomes rather than instructor attitudes. Morris’ work had relevance for the present study only to the extent that it shows education level to be a variable worthy of investigation. The literature provided no aid in interpreting this study’s result for the number of hours of graduate study in mathematics.

The minimum number of credit hours in an academic discipline for accreditation as an instructor in higher education is 18. This is often the total number of credit hours required for the “major” specific concentration in 36 credit hour master’s degree programs. The present study found results similar to Hathaway’s findings in secondary education (1983), a statistically significant relationship between higher levels of mathematics study by faculty and student success rates. This result combined with the pattern of all the observed success rates being lower than expected for the none and one to 18 credit hours categories and five of the six observed success rates being greater than expected at the 19 to 36 and 37 or more credit hours categories can be explained as follows.

The combination of the two patterns reveals a threshold for graduate study in mathematics that is associated with higher than expected student success rates. Simply put, the faculty person had to do more than the minimum level of required study to be associated with higher than expected student success rates. All six passing percentages in

the first two categories trend downward. Five of the six in the upper two categories, all three in the top category, trend upward. The threshold for association with greater than expected student success was 19 or more graduate credit hours in mathematics. The pursuit of this level of study may be related to personal interest, academic motivation or a more rigorous program. Each of these should be considered as possible explanations in respect to the results being described. However, a simple pattern that can be easily explained, the preferred scientific pattern (Rawlings, Pantula & Dickey, 1998, p. 398), is present and supported by the statistically significant results.

That faculty with no graduate hours in mathematics were uniformly associated with lower than expected student success rates and that one of these relationships was near statistical significant is compatible with the proposed explanation. That is, the persons furthest below the threshold are those most strongly associated with negative outcomes (p-values of 0.0741 for MAT 060, 0.3702 for MAT 070 and 0.0562 for MAT 080 – Table 4.9). Faculty with one to 18 hours of graduate credit in mathematics had lower student success rates at all three levels of instruction than would be expected. That persons approaching the threshold would exhibit negative relationships to student success but to a lesser extent than those further removed from the threshold fits the proposed explanation (p-values of 0.4384 for MAT 060, 0.6972 for MAT 070 and 0.6809 for MAT 080 – Table 4.9). That faculty with 19 to 36 hours of graduate study showed a different pattern than both categories below them, two out of three instructional categories with higher than expected success rates and one relationship that approached being statistically significant for higher than expected outcomes (p-values of 0.0613 for MAT 060, 0.8270 for MAT 070 and 0.5603 for MAT 080 – Table 4.9), fits the explanation and demarcates

the threshold. Finally, that all the student success rates were higher than expected at the next level, that they were statistically stronger at this level and that statistically significant relationships begin to exist in correspondence to an increased distance from the threshold (p-values of 0.1886 for MAT 060, 0.0136 for MAT 070 and 0.1699 for MAT 080 – Table 4.9), fits the proposed explanation.

The pattern just described must be considered in respect to the age, gender and employment status characteristics of each of the graduate hour categories. As noted above, all faculty in the one to 18 hours of graduate study in mathematics group were female. This characteristic would elevate the success rates for this group given the results for females in the study. However, the results for this level of graduate study were uniformly negative. The presence of a group completely made up of females in the one to 18 hours of graduate study group did not mask the pattern although it may have elevated the success rates for this group above what would otherwise be found. The 19 to 36 graduate hours group were approximately 67% full time. This may have impacted the pattern described. It would be expected, given the results for full time faculty, that 67% of the members of this group holding full time employee status would elevate the success rates above that which would otherwise be found. In light of this information, it is possible that the threshold for student success is not as accurately or precisely portrayed in the study results as described above. Finally, the faculty with 37 or more graduate hours of mathematics were all females. This would be expected to elevate the student success rates. This characteristic may have helped produce the clarity in the pattern described above. If this is the case, in combination with the high percentage of full time faculty in the 19 to 36 hours of credit category it may have accentuated or even distorted

the pattern. Given these considerations of possible influences on the results of the present study, the results should be considered a local manifestation until confirmed or disconfirmed by further research.

The present study advanced the understanding of the relationship of graduate hours completed by faculty and student success rates. It identified a possible threshold for increased student success rates in developmental mathematics at 19 credit hours of graduate study in mathematics by faculty although the results may have been impacted by confounding variables. As such, it has also identified a specific construct worthy of further investigation.

Higher Education Experience

Cumulative instructional experience in higher education. There was a broad spectrum of instructional experience in higher education among the faculty at the college. The categories utilized to group this experience were less than two years, three to five years, six to 10 years, 11 to 15 years, 16 to 20 years and more than 21 years. There were eight faculty members with two or less years of instructional experience in higher education. Five faculty had personnel records which indicated three to five years of higher education instructional experience. Five faculty had six to 10 years of higher education instructional experience. Two faculty had 11 to 15 years of higher education instructional experience. Two faculty had 16 to 20 years of higher education instructional experience. Two faculty had personnel records which indicated 21 or more years of higher education instructional experience.

The presence of faculty with extend experience in higher education is an anomaly in developmental education. Both Gross' (1999) and Harris' (1983) research describe

developmental faculty as being among the least experienced at institutions. In 2002 Stahl wrote the following regarding developmental education, “For so many of our programs, it has been less than a generation since they were birthed, and for so many of our colleagues, it has been less than a decade since they began their service to the profession” (p. 3). This is confirmed by research done with “the Exxon-funded National Study of Developmental Education database which contained information on 1072 developmental educators...[of] developmental mathematics [faculty]...70%... had 5 or fewer years of teaching experience” (Penny & White, 1998, p. 2). The research setting for this study included the opportunity to investigate the impact of extended experience teaching developmental mathematics on student outcomes. This was a significant extension of the understanding of factors which impact student success rates in developmental mathematics.

The faculty grouped in these subcategories taught sufficient numbers of students to be representative except in the 16 to 20 years of experience category for MAT 080 and the 21 or more years experience category for MAT 060. They showed sufficient diversity in respect to age, gender and employment status to limit the impact of these characteristics in the calculations performed with the exception of the 11 to 15 years experience and the 16 to 20 years experience categories in which all faculty were females.

Faculty with three to five years of higher education instructional experience who taught MAT 060 had a statistically significant association with lower than expected student success rates. Faculty with six to 10 years of higher education instructional

experience who taught MAT 060 had a statistically significant association with higher than expected student success rates.

The literature of developmental mathematics includes considerations of the impact of teaching experience. In Gross' investigation of the attitudes of faculty in departments teaching developmental education in the University System of Maryland "length of experience [did not]...impact significantly on...attitude toward teaching underprepared students" (1999, p. ii). Morris also considered the attitudes of developmental educators, specifically 341 math instructors at 32 Texas community colleges, with the result that "the number of years of teaching experience of faculty" (2004, p. 70) was not associated with their attitudes toward developmental education. Penny did not find "developmental mathematics teachers' ...experience" (1996, p. v) related to student outcomes in their last developmental course or their first curricular mathematics course. However, Lail found that early career instructors in the NCCCS "opted for lecture/short discussion format because of workloads, time constraints, and under-prepared students" (2005, p. i). The results of interviews conducted with developmental mathematics faculty by Davis showed that 75% believed that instructional experience on the part of faculty is most important for student success (1999).

The present study documented two statistically significant relationships for faculty instructional experience in higher education. Neither of these were in the categories 11 to 15 year and 16 to 20 years experience in which the all female composition of the group would have artificially elevated student success rates for the variable under consideration. However at the MAT 060 instructional level, the presence of an all female faculty group for the 11 to 15 years of experience may have prevented a

statistically significant negative association. In every other case with all female groups, the in group student success rate was above the expected level but not at statistically significant levels indicating no result influencing bias.

Given six categories and three instructional levels, 18 points of comparison were calculated. In all but one of the six points of comparison, which could have been biased by all female groups, no pattern indicative of bias was found. For the remaining group, the all female character may have inhibited a stronger negative outcome. The categories in which the two comparisons which were statistically significant occurred were also checked for biasing influences by cataloging the placement of each member of the group in respect to all the variables investigated in the present study. No biasing influences were discovered. However, as the significant results were in the MAT 060 instructional level, the potential bias introduced by the overrepresentation and underperformance of Black students must be considered. While it is possible that this factor influenced the negative result for the three to five years of experience group, it did not exert sufficient influence on the six to 10 years experience group to prevent a significant positive relationship. The research of Lail (2005) in which early career instructors limited classroom instruction to traditional lecture approach may also represent an influence on the present result. While Lail found this result among faculty with one to three years of experience, there is one year of overlap with the group three to five years experience.

As the relationship of the significant variables is negative in the 3 to 5 years group and positive at the same level of instruction in the six to 10 years group and no other significant relationships existed, few explanations are possible. The level of significance for the negative result in the three to five years experience category, $\alpha = 0.05$, may have

been influenced by the Black student count and lack of success but this would not account for the positive relationship in the next age category. A possible explanation is increased effectiveness through instructional experience. However, the MAT 070 and 080 levels of instruction have higher than expected success rates for the three to five year group and lower than expected for the six to 10 years group. While increased effectiveness at one course level, MAT 060, is possible that it would also be associated with a reversal of fortunes in the other two course levels is not probable. The remaining explanation is an unknown variable biasing the results.

As a number of uncertainties exist in regard to the statistically significant results for higher education experience, they should be considered as a documented local phenomenon across the four years of the study and not generalized until further research supporting the results is completed. However, the results do indicate that instructional experience is an important characteristic to consider as was the belief of 3 out of 4 developmental educators in Davis' study (1999).

Faculty instructional experience at the college. There was a broad spectrum of instructional experience in higher education among the developmental mathematics faculty at the college. The years of teaching experience for many of the faculty included extended periods at the college. The categories utilized to group instructional experience at the college, also the number of years of instructional experience in developmental education, were less than two years, three to five years, six to 10 years, 11 to 15 years, and more than 15 years. There were 10 faculty with two years or less instructional experience at the college. Six faculty had three to five years of instructional experience at the college. Two faculty members had six to 10 years of instructional experience at the

college. Faculty with 11 to 15 years of instructional experience at the college was a group of two. Four faculty were present with 16 years or more of instructional experience at the college. As noted above, the presence of faculty with extended experience in developmental mathematics is an unusual circumstance resulting in an extension of the knowledge of the field of developmental education through the present investigation.

With five categories analyzed in respect to student outcomes at three instructional levels the potential existed for 15 points of comparison. In several of the categories results will be interpreted with caution as the diversity in age, gender and employment status among the faculty was limited. There was only point of comparison in which a student sample of sufficient size was not possible. Faculty with six to ten years of instructional experience at the college taught no sections of MAT 080 during the four year period covered in the study. It should also be noted that the two faculty in the 11 to 15 years of experience category were the same instructors with 11 to 15 years of experience in the instructional experience in higher education. No other faculty group in the instructional experience at the college groupings corresponded one-to-one with the groups in experience in higher education.

Periodicals have included material regarding instructor experience and its impact in developmental education and dissertations have been written which consider this topic. The relevant literature was reviewed in the previous section of this document which was entitled “Cumulative Instructional Experience in Higher Education.”

Faculty with less than two years of experience at the college had a statistically significant negative relationship with student success rates when teaching MAT 060. As was the case in with “Cumulative Instructional Experience in Higher Education” Lail’s

2005 consideration of the NCCCS early career faculty coupled with Barker's finding regarding traditional instruction (1994) may explain this result for the least experienced instructor group. However, faculty with three to five years of experience at the college had a statistically significant positive relationship with student success rates when teaching the same MAT 060 course. Faculty with six to 10 years of experience at the college had a statistically significant negative relationship with student success rates in MAT 070. Given the erratic nature of these results, little can be said other than statistically significant results were found. In addition, a second pattern in the results exists which can not be explained in its entirety.

The results for four of the subcategories show uniform patterns in direction of impact. Faculty with two years or less of teaching experience at the college had lower success rates among their students than expected at all three levels of instruction. Two of these were statistically significant. Faculty with three to five years of teaching experience at the college had higher success rates among their students than expected at all three levels of instruction. Faculty with six to 10 years of instructional experience at the college had lower success rates among their students than expected at both instructional levels at which sufficient sample sizes existed. Faculty with more than 15 years of instructional experience at the college had higher success rates among their students than expected at all three levels of instruction. Only the uniformly negative relationship of faculty with two or less years of experience at the college with student success rates can be explained. In combination, the work of Lail (2005) and Barker (1994) explains this as a lack of experience and a period of adaptation.

That instructional experience at the college is significantly related to student success in developmental mathematics was demonstrated. The relationships for this construct, a subset of the previous variable “Instructional Experience in Higher Education,” are different than the previous variable. There were more points at which statistically significant relationships were found and the relationships of in group passing rates to expected was uniform for each subcategory of institutional experience. These two factors suggest that instructional experience within the local setting is more powerfully associated with student success than instructional experience in higher education. This is information new to the practice of developmental mathematics and to the field of developmental education. Further research is required to confirm this pattern and to understand any relationships within it. The significant relationships found in the current investigation are erratic and may have been impacted by unidentified variables as they do not follow a pattern which can be interpreted. However, the presence of multiple significant relationships and uniform patterns of impact for the experience categories employed reveals this is a construct worthy of further investigation.

Faculty rank. There are five possible faculty statuses at the research site. Part time faculty, a faculty status with no opportunity for advancement in rank, was considered above as an employment status and will not be reconsidered in the analysis of the faculty rank. To review, the statistical analysis indicated that part time instructors were significantly associated with lower than expected student success rates at all three levels of instruction. The ranks for full time instructors are Instructor, Assistant Professor, Associate Professor and Full Professor (RCC Faculty Senate, n.d.). These are common ranks in higher education which facilitate potential generalization of the result (Academic

Administration and Faculty Status Committee, Furman University, 2003; College of Liberal Arts and Sciences, University of Iowa, 2004; Gross, 1999, p. 84; Office of Academic Affairs, University of St. Thomas, 2000; RCC Faculty Senate, n.d.). Given four ranks and three levels of instruction, there were 12 possible points of comparison for this construct. However, 11 comparisons were calculated as no Full Professors taught MAT 060.

The college has one faculty member who served as a part time faculty person during the course of the study who had held a full time position in the past. This person had a long history with the college and had achieved the highest faculty rank possible. Although this faculty member was active in an adjunct capacity during the course of the study, the decision was taken to include this person in the faculty rank analysis as the rank Full Professor had been earned.

The ten mathematics faculty members who held a faculty rank were distributed across the four ranks as follows. Three faculty held the entry level rank of Instructor. Three others had earned the first advancement in rank to Assistant Professor. Two full time faculty members had reached the rank Associate Professor. Two faculty held the highest possible academic rank, Full Professor.

The faculty groups formed by academic rank taught sufficient numbers of students to be considered representative groups for every comparison except Full Professors teaching MAT 060. No Full Professors taught MAT 060 during the four years of the study. The diversity in respect to age, gender, and employment status was limited by the number of subjects in each group and the exclusion of all but one part time faculty member.

Faculty rank is a construct that has received consideration in respect to its influence on faculty in the general literature of higher education (Colbeck, 1992; Lei, 2003). For example, Lei found that faculty rank influenced classroom practice (2003). Colbeck's work noted that after achieving tenure faculty were motivated to persist in emphasizing the behavior, teaching or research, they perceived had been rewarded by being awarded tenure (1992). The literature of developmental mathematics also includes investigations of faculty rank. While Gross found no significant association between faculty rank and attitude toward developmental education in the University System of Maryland, the results reported included "professors, associate professors, and assistant professors were less positive in their attitudes than were instructors and lecturers" (p. ii). Faculty rank has been linked to classroom practice and faculty motivation in higher education and found to display a pattern in relationship to attitude toward developmental education among developmental educators. In the present study, faculty rank was statistically related to student success rates at a number of levels of instruction in developmental mathematics.

In MAT 060, Assistant Professors were associated with higher than expected student success rates at an $\alpha = 0.04$ level. In MAT 070, Instructors were associated with higher than expected student success rates at an $\alpha = 0.02$ level while Assistant Professors were associated with lower than expected student success rates at an $\alpha = 0.01$ level. At the MAT 080 level, Associate Professors were associated with higher than expected student success levels at an $\alpha = 0.03$ level. The importance of these results is not in the associations at the three levels of instruction, rather it is that statistically significant

relationships existed and that a pattern is displayed when a matrix of faculty ranks and student passing rates calculated for each rank and instructional level is constructed.

Faculty rank is a complex construct. The rank system at the college recognizes longevity, instructional innovation and creativity, commitment to the institution and its students, academic and professional accomplishments, service to the community and personal growth (RCC Faculty Senate, n.d.). That the results related to this variable were not uniform in the present study is not surprising given the number of factors subsumed in the variable.

The complexity of the construct faculty rank limits interpretation of the course specific results of the study. Given the list of factors included in faculty rank calculations, the possibility exists that any of a number of these factors could be influencing the relationships at any of the points of comparison. However, the presence of four statistically significant relationships and the fact that three of the four, one at each level of instruction, were associated with one faculty rank indicates that the rank of the faculty member teaching a developmental mathematics course at the college is an important variable in the student success equation. Why this is the case can not be determined from the outcomes of the present study.

The student sample employed for the dissertation was large enough to allow the student samples formed for faculty ranks to be subdivided based upon various factors utilized in the rank calculations. However, the number of mathematics faculty who had an academic rank was small and would not support such subdivisions. An expansion of both the student sample and the number of faculty considered would be necessary to pursue an understanding of the particulars of the relationship between faculty rank and

student success rates at the college. However, that statistically significant relationships were found between three ranks and student success rates and that at least one of these relationships existed at each level of instruction is a contribution to the knowledge base of developmental mathematics.

A second contribution to the knowledge base of developmental mathematics from the results for faculty rank in this investigation is the pattern portrayed in the four by three matrix of passing rates (Tables 4.17, 4.18). There is a pattern of inversion of success rates between the MAT 060 and MAT 070 instructional levels for all ranks that taught MAT 060. The overrepresentation and underperformance of Blacks in MAT 060 could have decreased the expression of this pattern but could not have strongly biased it given the direction and extent of differences in the frequencies. There is also a pattern of uniformity of direction in student success rates in the two upper levels of instruction (i.e. both positive, both negative). This supports the formation of a hypothesis that one or more course content specific factors interact with the complex variable faculty rank to produce effects on student success rates. Course content specific distinctions exist and are evident in the class names, MAT 060 Essential Mathematics (RCC, 2007), MAT 070 Introductory Algebra (RCC, 2007) and MAT 080 Intermediate Algebra (RCC, 2007). The pattern observed may indicate that course specific factors impact or interact with the traits investigated in the present study. This hypothesis is supported by the work of Merisotis and Phipps which suggests a similar pattern (2000, p. 82). An investigation of this hypothesis has the potential to expose the particulars of the relationships. As such, the results of the present study extend the knowledge in developmental mathematics and provide an avenue for investigation of the interaction of the factors in the complex

variable faculty rank, course content specific factors in developmental mathematics and student success rates.

Implications for Practice

Approximately half of the community colleges in the United States are in rural settings or small towns (Phillippe & Sullivan, 2005, p. 16, 18). As noted in a previous chapter, all community colleges teach developmental mathematics and many of their students require these courses. As the study was conducted at a rural community college and all community colleges teach developmental mathematics, the study results have direct implications for all rural community colleges in the United States, a large percentage of the community colleges in the nation. This is a broad and dramatic potential scope of generalization. The study also has indirect implications for all community colleges and institutions of higher education offering developmental mathematics, nearly every college or university in the country. However, any generalizations from the present study to other institutions should be made based on the presence of corroborating evidence and placement policies, levels of instruction, student population and faculty similar to those at the research site.

Community Colleges

There are five areas in which the study has implications for practice in community colleges. The study results have strong implications for faculty recruitment. The study has implications for departmental or instructional planning. A third area of implications is faculty professional development. Many implications from the study exist for institutional planning. The final area of implications for the results of this study in community colleges is research. The exploratory or groundbreaking nature of the study

limits the immediate applicability of the results in respect to the majority of variables to the area of research. However, several of the results have sufficient corroborating support in the literature that responses to the implications of the study should be strongly considered.

In respect to the general results of the study, the following may be stated. The presence of statistically significant relationships for many of the variables considered introduces the need for community colleges to consider the implications of the study for all five areas, faculty recruitment, department planning, professional development, institutional planning and research. The complex and occasionally counterintuitive nature of the relationships found calls for additional research to confirm the study results. Specifically, it calls for local institutional research to inform a careful weighing of faculty characteristics for which an institution recruits developmental mathematics faculty and upon which it plans for the future. Apparent interaction of course content specific factors with faculty experiential and personal characteristics in influencing student success rates requires local confirmation through research but implies value in recruiting and training specialists, planning or retooling a professional development program to accomplish this and informing the colleagues of these specialists of the support for, purpose in and process of this endeavor. Finally, the areas in which strong statistically significant results were found which also have corroborating support in the literature imply a need to incorporate these constructs in faculty recruitment, department planning, professional development, institutional planning and research.

As regards the specific variables and subcategories of variables investigated, research is the area in which the greatest number and most direct implications lie for

community colleges and professional development is the area in which the least are found. That much of the present study was groundbreaking research in developmental education implies a need for research to confirm, disaffirm or refine the understanding of the results. Every result reported in the study requires replication as most are unprecedented and those that are not draw support from studies that do not directly parallel the present study. Since the variables investigated were personal traits and experiential factors, the implications of the results for professional development are the most limited. Very few of the variables considered in the study could be developed on campus by faculty following employment. However, the results achieved related to topics of study in graduate programs and graduate credit hours have strong implications for professional development. These outcomes suggest that professional development for instructors in developmental mathematics should include a focus on specific major areas of study and helping faculty to reach a threshold of study, or perhaps more accurately, colleges should recruit faculty who have a desire to complete more than the minimum number of graduate hours required and find a way to instill the motivation for present faculty to do more graduate work than the minimum required for accreditation.

Assuming support from local institutional research, many of the results of the study imply actions to be taken by community colleges in recruiting faculty for developmental mathematics. Information from the present study indicates that age, gender, educational background and goals and, possibly, relationship to the majority local culture of the institution's setting are worthy concerns when recruiting faculty for the developmental mathematics instructor pool.

Many of the results of the study imply actions to be taken by community colleges in instructional or departmental planning and institutional planning. A significant number of the results found in the project completed for this dissertation were unique or unprecedented. An important implication for institutions is that funds and personnel for research be set aside to confirm, disaffirm or refine the understanding of the outcomes of the present study before they are applied in local contexts. While controversial, the results of the present study imply that funding for as many full time developmental mathematics instructor positions as possible be secured and incorporated into long term institutional planning by community colleges. Further, an institutional initiative should be established to identify the preferred faculty profile for a developmental mathematics instructor with the characteristics assigned some rubric for prioritization. Purposeful monitoring of the demographics of the developmental mathematics faculty and associated student success rates is also warranted. Finally, the results indicate that significant funding for and planning of professional development that can lead to the attainment of high levels of graduate credit hours in mathematics by developmental mathematics faculty is necessary at community colleges. This may require an institution to establish partnerships with other institutions. These partnerships would allow the creation of cohorts of current developmental faculty that may be provided graduate course work in convenient locations and at appropriate times on campus, might establish partnerships that include shared faculty so that more full time personnel can be employed, or could create time and opportunities for developmental mathematics faculty seeking graduate education to act as tutors or in a Supplemental Instruction program at a university in exchange for tuition free graduate study or other such arrangements. In short, the

implications of the study for instructional, department and institutional planning are for rigorous, deliberate, informed, learning centered, creative, long-term planning.

In addition to the implications for community colleges, the study has implications for higher education, for community college system administrators and politicians who set policy and goals for community college systems, and for individuals. These will be addressed in the order in which they are listed.

Higher Education

The most direct implications for higher education proceed from the lack of significant results for faculty members with degrees in secondary education, the absence of positive results for instructors with graduate degrees in Education, the threshold of graduate hours of mathematics studied which was associated with positive student outcomes, and the results related to the gender of instructors. The present study implies that institutions of higher education must reconsider the tracks of specialization and the instruction they provide in the academic discipline Education.

That instructional tracks and instructional content of degrees in Education should be reconsidered is evident as undergraduate training in facilitating secondary education and graduate degrees in Education were not associated with statistically significant influence on student outcomes and, in one instance, a graduate degree in Education had a statistically significant negative relationship with student success. This suggests a possible need for a retooling of the programs, as developmental mathematics considers topics taught in middle school and secondary settings, and the addition of a new area of specialization, developmental mathematics. However, in light of the differences between secondary education and higher education described above, it is the opinion of the

researcher that a specialization in developmental mathematics at both the undergraduate and graduate level is the preferred option.

Beside retooling programs and adding possible areas of academic specialization, the study suggests that decision makers in higher education, both institutional and accrediting agency personnel, should reconsider the number of graduate hours of mathematics required and the topics incorporated in graduate mathematics degrees. A third option would be to strongly encourage the completion of additional graduate work in specific areas of specialization. This is the case as the study found that more than 19 hours of graduate mathematics is completed by instructors who had a positive influence on student success rates in developmental mathematics. In addition, the results suggest it would be wise to identify an area of instructional specialization for each developmental mathematics faculty person as no individual instructor showed high student success rates at all three levels of instruction and the cumulative results show that association with higher than expected student outcomes at one level of instruction is not a predictor of the same at other levels of instruction. Further, the results appear to support pursuit of certain areas of specialization in mathematics as opposed to others. This might be accomplished through programs of study which address these topics or a requirement for continued tutelage in mathematics for developmental mathematics instructors.

The study also suggests that institutions of higher education should pay particular attention to the gender of their mathematics students. That females were associated with higher than expected student success and males with lower than expected student success is both a call for recruitment and intervention. Female students should be courted to pursue degree programs which will qualify them as developmental mathematics

instructors. However, males should not be excluded. The male mathematics education students should be provided additional or specialized programming to increase their potential effectiveness as instructors.

System Administrators and Politicians

The study also has implications for policy makers within community college systems and those in the political realm who evaluate the effectiveness of community college systems. The implications for these persons relate to their oversight and planning for community colleges. These implications are in the areas of standards, personnel, cooperation between community colleges and four year institutions and open discussion of the challenges faced in developmental mathematics.

The data set and results of the present study suggest that there is still much work to be done in meeting acceptable levels of performance in developmental mathematics. Persons supervising community college systems and politicians who evaluate and fund community college systems can impact this pattern by establishing goals. With input from researchers and experts in developmental education, standards and criteria for excellence could be drafted for developmental education. Where standards exist, they should be revisited and evaluated for validity based upon research completed.

Persons responsible for oversight of community college systems, whether as system employees or representatives of the executive and legislative branches of government, could receive guidance regarding personnel policy for developmental mathematics instructors from the results of the present study. The results suggest that full time instructors, female faculty, persons with more than 19 hours of graduate study in mathematics and individuals who are committed to their institutions produce higher than

expected student outcomes. A preferred profile for developmental mathematics faculty could be developed based upon this research and other studies. In addition, investigations should be consider to understand why females were associated with higher than expected passing rates and interventions planned to aid male instructors in improving effectiveness as males can not be legally dismissed or barred from employment based upon their gender.

The results suggest that increased cooperation between four year schools, graduate degree granting institutions, and community colleges should be emphasized. This is the responsibility of the persons, system based or government oversight based, who supervise, direct and fund the community college system. The apparent need for a specialization in developmental mathematics at the undergraduate and graduate level and the suggested need for extended consideration of mathematics at the graduate level in specific topic areas for persons who teach developmental mathematics would be the focus of this cooperation. The present study suggests that the community college system, whose faculty members are developed by the four year institutions, should call for revisions in academic programming at these institutions to bring them in line with the results presented above.

Each of the implications for system supervising personnel would be facilitated by an increased transparency in respect to developmental education. To justify and facilitate the changes described above, an open and forthright exchange of information is required. As few persons outside developmental education clearly understand the field and its practices and the low passing rates make institutions unwilling to share detailed and specific information, many misunderstandings have been formed regarding

developmental education. Nothing short of unbiased disclosure of the circumstances and outcomes in this area of practice is necessary for persons removed from the process to make wise decisions. An indirect implication of the study is that it is imperative that transparency before system personnel, political representatives and the public be increased in regard to developmental mathematics.

Individuals

Finally, the results of the study have implications for individuals, both faculty persons and students. The increase in transparency regarding the practice and results of developmental education would be required for many of these implications to be recognized by faculty and students and acted upon.

The implications of the study for individual faculty members arise from the areas of statistically significant results. As noted above, the results of this study indicate that the full time faculty, female faculty members, instructors with more than nineteen hours of graduate mathematics, persons who studied Statistics in graduate school and individuals with a significant commitment to the practice of developmental education as represented by involvement in activities which allow for advancement in academic rank at the college were associated with higher than expected student success rates. This has implications for faculty advising students who need developmental mathematics which will be considered below. The implications for individual faculty members teaching developmental education are that they investigate their relationship to student success rates and conduct a personal inventory based upon the list of attributes above, seek a full time position or seek to emulate the practices of full time faculty, try to understand the reason that the women in the study sample were more effective, expand their graduate

mathematics consideration beyond 19 hours, consider studying Statistics in those graduate courses, and become integrated into the activities valued in the institutional culture and faculty rank evaluations. Simply stated, the results of the study suggest that developmental mathematics faculty should take responsibility for moving their personal and academic activity toward the profile which emerged from the investigation.

The implication for the individual student, given a disclosure of information like that found in this dissertation, is to be proactive and selective. In every registration cycle students and their advisors have an opportunity to seek out faculty who meet the profile described above. Given the statistically significant differences in student success rates associated with some faculty traits and characteristics, the student alone or under the guidance of an advisor would be wise to include these constructs when determining in which of the available developmental mathematics courses to register.

Summary

The results of the present study have broad and far reaching implications. They extend from verification of the results through research to long-term institutional planning and commitments, professional and political oversight of community college systems, programming in higher education and the planning by individual faculty and students. However, they are limited by several characteristics of the setting, the data set, the research model, and the statistical package.

Limitations

A number of limitations apply to the study. These are related to the college at which the investigation took place, the information available in personnel records, the

size of the faculty sample, the data available about students, the model upon which the study was based, and the statistical package employed.

The characteristics of the college at which the study was conducted reflect choices made by the North Carolina Community College System and by local administration and faculty. As such, the courses taught during the scope of the study cannot be expected to represent developmental mathematics courses within all community colleges and community college systems (Penny, 1996, p. 14). Generalization and application of the results will require a setting similar to that of the study.

Further limiters for generalization of the study results exist which are related to the size of the college and its setting. While 49% of the community colleges in the United States are the same size as or smaller than the college which served as the research site (Phillippe & Sullivan, 2005, p. 16) and 33% of the colleges are in small towns or rural settings (Phillippe & Sullivan, 2005, p. 18), many community colleges are larger and in suburban and urban settings. The ability to generalize from the results of the present study to other community colleges is impacted by the differences in size and setting.

A third limitation of the study was the limits on information captured and maintained in college personnel records. The choice was made to use personnel record information to determine the presence or absence of characteristics among faculty because the records in the personnel files have been verified by the college personnel department. Having made this choice, the researcher was limited to investigating faculty characteristics which are described in personnel files. Additional personal traits and experiential and background characteristics of faculty exist which are worthy of investigation in respect to student success rates but are not described in personnel

records. Generalization will be possible only in respect to the specific characteristics described and faculty and student populations similar to that found at the research site.

The study includes all faculty teaching developmental mathematics at a North Carolina community college across a four year period. However, this is not a large group. The study considers the characteristics of these 24 faculty members, a relatively small number but similar to that in other dissertations in the topic area (Fike, 2005; Penny, 1996). The study was, as a result, limited to investigation of characteristics present within this group. Results may be generalized only to the extent in which a similar group of instructors exists in a similar setting.

The period across which the study was conducted and the ability to sort the sample by student characteristics was limited by the information available at the college. To reach a count of 24 faculty, the data set had to extend across a period of four years. Within this period, the college had updated their student record software. The result for the study was a limiting of the characteristics of students that could be considered. From fall of 2005 forward, the college records are computerized and accessible through a software program in which student outcome data can be accessed in multiple ways. However, the transfer of the records from before the fall of 2005 to the new software package had not been completed while the researcher was constructing the data set. More limited physical records were employed to complete the first two years of the data set. These records could not be sorted to consider the individual outcomes and records of students. This characteristic limited the number of dependent variables considered and the extent to which the sample could be grouped in homogenous categories. Only grouping by entry level mathematics skill which determined course enrollment was

employed. Subsequently, the results can only be generalized in respect to groups of students with similar characteristics studying in similar settings and specifically at the skill level or levels found in the study.

The study employed Astin's model. In this model there is no control for environment factors external to the college which may not change student inputs but might mitigate, minimize or intensify them and their potential impact. An example is loss of employment with potential cascading effects in respect to student attention and attendance. Further, other environmental factors may exist which impact student outcomes in developmental mathematics that were not investigated. Only the impact of environmental factors related to faculty, as defined in Astin's model, were studied.

The final limitation of the study was related to the statistical package employed. The statistical analysis did not prove causation only association and probability of chance occurrence. Therefore, the results provide information regarding the association of personal traits and experiential characteristics of faculty with student success in developmental mathematics and the probability that a relationship of this type might occur by chance, not evidence of casual relationships.

Recommendations for Further Research

The general results of the study indicate a need for further research in the following areas.

1. In light of the complexity portrayed in the relationships found, studies which allow for investigation of the impact of the components of each variable and the formation of models are recommended.

2. In light of the support for course specific distinctions in success rates, studies which consider variables included in the present study in relationship to course content and other particulars of the three course levels and student success at each level are recommended.
3. As three variables or subcategories of variables had statistically significant relationships with student success at all three levels of instruction and two others had statistically significant relationships with student success at two levels of instruction, studies seeking to replicate the present investigation in similar and dissimilar settings are recommended.

The results for each of the variables investigated indicate a need for further research in the following areas.

1. It is recommended that researchers investigate the relationship found between faculty age 45 to 54 years and student success in similar and dissimilar settings to increase understanding of impact of these characteristics.
2. It is recommended that studies be planned to increase the understanding of the relationship between faculty gender and student success rates in developmental mathematics found in this study.
3. In response to the research results reported in the literature and those in this investigation studies seeking to determine whether the impact of faculty employment status on student success rates in developmental mathematics is site specific are recommended.
4. As faculty residence in the county served by their employer was found to be negatively related to student success in developmental mathematics, studies

seeking to replicate these results in similar and dissimilar settings and delineate the traits and attitudes of faculty based upon county of residence are recommended.

5. As community college faculty have historically included a large number of persons with instructional experience in secondary education (Cohen, 2003, p. 77), studies seeking to replicate the absence of significant relationships between this characteristic, investigated in two different manners in the present study, and student success rates in developmental mathematics are recommended.
6. Since faculty who graduated from a community college were found to have no statistically significant relationship to student success rates in developmental mathematics at a community college, studies planned to affirm or disaffirm this result in rural and urban settings are recommended.
7. As no statistically significant results were found for developmental mathematics faculty with only a bachelor's degree, studies seeking to replicate these results in similar and dissimilar settings and delineate the traits and attitudes of faculty based upon level of education are recommended.
8. In response to the lack of statistically significant results for developmental mathematics faculty with an undergraduate degree in secondary education, research seeking to replicate these results in similar and dissimilar settings and to delineate the traits and attitudes of developmental mathematics faculty based upon possession of an undergraduate degree in secondary education are recommended.
9. As the possession of a graduate degree in Education was found to have a statistically significant relationship with lower than expected student success at

one level of instruction and no relationship at the two other levels of instruction, research seeking to replicate these results in similar and dissimilar settings and to delineate the traits and attitudes of developmental mathematics faculty based upon possession of a graduate degree in Education are recommended.

10. In light of the finding that some major areas of graduate study on the part of developmental mathematics faculty have significant relationships with student success rates, studies seeking to replicate these results in similar and dissimilar settings and to delineate the traits and attitudes of developmental mathematics faculty based upon pursuit of a specific graduate major are recommended.
11. As the results of the present study indicate there may be a threshold at which the relationship between the graduate hours of mathematics earned by faculty members and student success rates in developmental mathematics move from positive to negative further studies are recommended to investigate this pattern.
12. As statistically significant results were found in the present study for the relationship between faculty instructional experience in higher education and student success rates in developmental mathematics but these results did not occur in a regular or interpretable pattern, further study regarding the relationship between these variables is recommended.
13. Since the results of the present study suggest that instructional experience within the local setting is more powerfully associated with student success rates in developmental mathematics than instructional experience in higher education and because these results are unprecedented in developmental education literature and

display no readily interpretable pattern, further research regarding the relationships between these variables is recommended.

14. As faculty rank is a complex construct composed of many factors and the relationships that were found between this construct and student success rates in developmental mathematics could not be interpreted by the researcher, studies pursuing an understanding of the particulars of the relationship between faculty rank and student success rates are recommended.

Summary

This dissertation addresses a concern common to all regions of the United States, all institutions of higher education and to the future of the American work force, student success rates in developmental mathematics. Statistically significant relationships were found between faculty traits and attributes and student success rates at all three levels of instruction. These results have strong implications for the institution at which the research was conducted, for all other rural community colleges in the United States and indirectly for all community colleges. As the results for many of the constructs investigated are unique to the present study due to the limited number of investigations undertaken regarding the impact of faculty traits and characteristics on student success in developmental mathematics and the unprecedented nature of some of the variables included in the present study, replication of the study is necessary to verify the veracity of the results.

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APPENDIX A – ARCHITECTURE OF DEVELOPMENTAL EDUCATION

LITERATURE

Developmental education is a young discipline even though it has roots in services provided to underprepared students at institutions of higher education for over 150 years (Neuburger, 1999; Arendale, 2002). The phrase developmental education, the organizations for practitioners, and the publications in the field are between 30 years and 40 years old (Clowes, 1980; Armington, 2003; Boylan & Bonham, 2007). Further, the nature and scope of developmental education is an item of continuing debate (Higbee, 1996; Cassaza, 1999; Davis, 1999; Bruch, 2001). As a result, no hierarchical system showing the relationships between various constructs has been developed for the field. In addition, meta-analytical studies and extensive critical reviews of the literature of developmental education are few in number. Therefore, the statements made by authors in the field describing the scope and nature of the literature are often brief and subjective or based upon a topic specific sampling of the literature (Wheland, Konet & Butler, 2003; Trenholm, 2006). This circumstance did not allow the author of this document to identify the emphasis placed on developmental mathematics in the literature of the field of developmental education when writing his dissertation and he was unable to portray the balance between this emphasis and that given other critical concerns in the field of developmental education. To facilitate characterizations of these types, the author developed a proposed architecture of the literature of developmental education.

The author chose to refer to the architecture developed as a proposed architecture for a number of reasons. First, the proposed architecture was the work of one person and

may reflect bias. Second, the method was based upon a sampling of the literature rather than categorization of the literature in its entirety. Third, the literature of developmental education continues to develop and expand. Therefore, the structures and relationships portrayed in the architecture may have changed. The term architecture was employed as the project sought to portray both the logical relationships that exist between various topics in the literature and the weight given to any particular topic in the literature. Architecture was judged by the author to best portray this consideration of the structure of, relationships of the components of, and relative size of the components of the literature of developmental education.

Method

The content of a variety of publications was analyzed to develop the proposed architecture. Each of these publications is considered a major resource in the field of developmental education (O'Hear & MacDonald, 1995; Boylan & Bonham, 2007). Each article published in *Research in Developmental Education* (RiDE) from its inaugural issue in 1983 to Volume 21, Issue 3 in 2007 was included. Nearly every article published in the *Journal of Developmental Education* (JDE) from its first issue under this title, 1984's Volume 8 Issue 1 (Boylan & Bonham, 2007), to Volume 30, Issue 3 in the spring of 2007 was considered in creating the architecture. The articles, interviews, editorials, and regular columns from JDE were categorized and cataloged but introductions to special issues and the contents of one regular feature, "For Your Information," were not. The introductions were excluded as they described the purposes of and outline for the special issues rather than providing scholarly opinion or content. The "For Your Information" feature was excluded as it is comprised of a collection of short news worthy

or noteworthy items. Including this content would have involved categorizing and cataloging each section of the feature for every issue of the publication. The result of coding the sections of the feature individually would be to provide a single edition of the feature the weight of multiple articles in the publication skewing the relationships of topics in the cumulative counts for the JDE. The entire count of articles published in *Research and Teaching in Developmental Education* (RTDE) from 1998's Volume 15, Issue 1 to 2006's Volume 22, Issue 2 was included in the analysis. Each of the monographs published by the National Association of Developmental Education (NADE) between 1996 and 2003 was analyzed and cataloged as well as the digests 1.2 through 3.1. These monographs and digests were considered as issues of one collective publication. All articles and book reviews from the NADE monographs and digests were included in the proposed architecture, the introductions to each volume provided by the editors were not. Finally, abstracts for 33 doctoral dissertations completed between 1980 and 2005 which are related to developmental mathematics were analyzed and cataloged. The combined total of articles and dissertation abstracts considered in the development of the proposed architecture was 796 units.

Several existing systems for categorizing publications were considered as possible templates for the architecture of the literature and rejected. Each would have established a predefined set of abstract concepts under which to classify the subjects addressed in the literature, a deductive approach. The systems of this type considered were the Library of Congress (Library of Congress, n.d.) and Dewey Decimal (Thompson-Nicola Regional District Library System, n.d.) classification systems and an initial sort of the works by type of literature. Adopting these systems for the purpose of developing an architecture of

the literature of developmental education was rejected as being inconsistent with the goals of the project and as having significant potential to skew the results of the project or impose limits on integration of all aspects of the literature.

The Library of Congress and Dewey Decimal classification systems were rejected as being inconsistent with the goals of the project and for having the potential to skew the results. These systems were developed with the entirety of human knowledge in view. As a result they include multiple levels of abstract categorization before reaching the level of specificity at which the field of developmental education would be considered. Further, neither of these systems presently identifies developmental education as a distinct unit. As a result, use of these systems did not serve the purpose of the project, describing the literature as it has developed, as extending each system would have been necessary to reach the level of specificity required. Extending them deductively would have involved the generation of a series of increasingly specific levels of categories under the existing Library of Congress or Dewey Decimal subheadings. This would have imposed predetermined descriptors on the literature of developmental education rather than ascertaining logical relationships as they have developed in the literature. The potential result could include “square pegs in round holes” or could be skewed by self fulfilling prophecy (finding what one expected to be present). The same potential errors also seemed likely if an attempt had been made to develop an ascending and inductive categorization of the literature to marry to the Library of Congress or Dewey Decimal subheadings. However, for the proposed architecture some category headings in the subclass “LB” (Library of Congress, n.d.) of the Library of Congress system were borrowed or modified. This occurred in respect to the final version of the proposed

architecture with the headings “Administration and supervision”, “Educational theory and practice”, and “Theoretical systems.”

Another pattern considered for the creation of the architecture of the literature was primary divisions based upon type of literature. The author considered dividing the literature into the groups roughly corresponding to research reports, reports of scholarly and practitioner opinion, and other literature. This approach was also rejected as the reports of research results, discussions of scholarly opinion or practice and the remaining balance of the literature address the same content areas. Employing these three categories would result in three roughly parallel outlines of the literature rather than one integrated outline of the literature and was therefore rejected.

Material accessible on the websites of RiDE, RTDE and NADE, in the periodical collection of a university library, and on the Ebscohost database was employed in constructing the proposed architecture. The pattern employed to construct the proposed architecture of the literature involved content analysis through descriptive labeling and comparison, a qualitative research pattern described as “descriptive content analysis” (Neuendorf, 2002, p. 53). “Human coding” (Neuendorf, 2002, p. 50) of the material sampled was employed. The “unit of data collection” (Neuendorf, 2002, p. 50) was article length publications in the periodicals listed above. Individual classification of article content and comparison was employed in developing the labels for subcategories, categories and primary headings and the relationships between them, a process Duranczyk describes as “analytical induction and constant comparison strategies” (2007, p.27). This process is widely known as outlining, a system taught to students for note taking (Kanar, 2004, p. 233), employed by academics (Adler, 1981, pp. 13-27), and

which functions as the basis of describing the relationships identified in the coding of qualitative data.

While the outlining pattern employed was primarily an inductive approach it was begun utilizing the categories developed by O’Hear and MacDonald in their two part critical review of the research in developmental education published in 1995 and 1996. They divided the publications considered in their review into eight categories by subject matter (O’Hear & MacDonald, 1995). These categories are “Reading...Program concerns...Writing...Study skills...Students...Math...Multiple skills...[and] Tutoring” (O’Hear & MacDonald, 1995, p. 3; MacDonald & O’Hear, 1996). These eight descriptors or primary headings were employed as the initial “outline/key word” (Kanar, 2004, p. 120) system. This list did not include each of the “seven major research and practice areas” (Lundell & Collins, 1999, p. 5) identified by NADE but expanded to include each of them in the process described below. One researcher completed all the coding. Frequent and extensive “spot checking” (Neuendorf, 2002, p. 50) of the classifications was employed to ensure reliability of the resulting architecture of the literature as described below.

The rough outline composed of eight “key words” (Kanar, 2004, p. 120) or phrases was then used to begin a sort of the material in the literature. Articles were categorized by subject matter and assigned a subject matter descriptor. These descriptive labels were derived first from the title of the article and confirmed through a reading of the abstract. In the instances in which some uncertainty remained about the appropriateness of the assigned descriptor, the entire article was read. The assigned descriptors were then compared to the eight point outline or a later revision of it. When

subject matter descriptions for articles matched the existing set of outline headings, the article was include in the list of material assigned to the existing heading. When the descriptor did not match an existing heading in the outline, the subject matter descriptor was added to the outline as a topic or subcategory. Every effort was made to utilize terms or phrases in the headings, categories and subcategories which would be self explanatory. Each major grouping of content in the proposed architecture (heading, categories, subcategories) includes a mixed content section as some published material addresses multiple subject areas, a number of purposes, or both (Boylan, Bonham, & Bliss, 1994; Jahangir, 2002; Johnson, 1994). The outline was developed and applied one publication at a time.

In the process just described, it became clear that a sort of the articles based upon subject matter would be inadequate. It did not allow sufficient differentiation in some areas of the literature. For example, not all articles discussing developmental reading focus on instruction. Some articles describe particulars in planning institutional characteristics to support a reading instruction program, others describe theoretical systems to use in the design of instructional programs, still others describe the viewpoints of persons from outside developmental education regarding the programming and instruction taking place in developmental education. A second characteristic of each article was considered to aid in categorizing the articles, purpose. For example, was the author's purpose to describe the results of classroom research, to explain the particulars of a theoretical construct applicable within the field of developmental reading, or to inform readers of the potential impact of popular perspectives or state and national legislation on developmental reading programming? The combination of the subject

matter and the purpose of the author resulted in a simple, useful, and effective classification tool.

The articles published in RiDE were the first to be categorized employing the eight point outline. The outline remained without subjugation until all 100 articles in RiDE had been classified. At this point, an attempt was made to identify and represent the logical relationships between some of the headings by placing them in a hierarchical outline. The resulting outline had only primary headings and one subsumed level of associated categories. This outline was then applied to the 85 articles published in RTDE between 1998 and 2006. The same pattern of labeling, comparison, and cataloging under an existing heading or creation of a new heading was utilized. The result was an increase in the breadth and depth of the outline. The expanded outline was then applied to the content of RiDE which had already been classified and sorted. Each descriptor previously assigned to articles and the position they had been assigned in the outline of content found in their “home” publication was reconsidered in light of the revised outline of the literature. Any adjustments made necessary by the increased specificity of the outline were made to the article classification list for RiDE. The 97 articles found in the NADE monographs and digests were then considered. The same pattern of adaptation of the outline based upon the characteristics of the new literature and regression of the adapted outline upon already classified literature was conducted. The result of this process was a four level outline of content from these publications and catalogs of the articles in each publication and their respective classifications which had been repeatedly viewed for accuracy.

The contents of the JDE were reserved for classification until a substantial outline had been generated using RiDE, RTDE and NADE materials. 481 articles, excluding introductions to special issues and the feature “For Your Information,” were published in the issues consulted. Seeking to classify this large and diverse body of literature served as a test of the breadth, depth, and function of the outline created employing RiDE, RTDE and the NADE monographs and digests. When classifying the JDE content, adaptations were made to the outline. These adapted outline was regressed upon the previously completed classifications for RiDE, RTDE and NADE publications. Following this, the classification of each article in the JDE was also reviewed. At this point, the outline had become an architecture of the literature as it was based upon a thorough review of over 750 articles published over periods of seven to 24 years in four major publications in the field. It represented the topics in the literature, their relationships, and the volume of material associated with each topic.

The final test to which the proposed architecture was subjected was ability to accurately classify and describe content in a specific subcategory of the literature. For this purpose the author selected abstracts from 33 dissertations published between 1980 and 2005. Each of these dissertations focused on developmental mathematics. The proposed architecture was able to separate these publications related to one content area in developmental education into their areas of emphasis. The utility of the proposed architecture in sorting a diverse and complex set of published materials like that in the JDE and a content area specific set of investigations like that represented by the 33 dissertation abstracts was evidence that it described and could be used to characterize the literature of developmental education. It supports the accuracy of the logical relationships

between the topics addressed in the literature as portrayed in the hierarchical pattern of the proposed architecture. That very few of the published articles in the four periodicals and the collection of dissertations are classified in the “catch all” categories of mixed content are is also support of the accuracy of the hierarchy of the proposed architecture.

Result

The proposed architecture is found in left hand column of Table 1. This table also represents the percentage of published content assigned to each primary heading, category, subcategory and topic in the literature employed to development the architecture. The percentages associated with the bold primary headings include all the content subsumed under the primary heading. That is, considerations of “Developmental Programs” comprise 85% of the sampled content of RiDE and 76.4% of the JDE. The percentages associated with the category titles, for example “Persons/participants,” “Equity, access and balance issues” and “Historic or predictive,” include all the material in their respective subcategories. Each subcategory percentage represents only the content in that subcategory but includes any topics subsumed under that subcategory. So, the 5.2% of NADE content in the subcategory “Support programming” is a total of the content in the subsumed topics, “Tutoring,” “Supplemental Instruction,” etc. Subcategory percentages have a total equal to the category percentages which total to equal the percentages associated with the primary topic headings.

Table 1

A comparison of content between NADE digests and monographs, Research in Developmental Education, Research and Teaching in Developmental Education, the Journal of Developmental Education and selected dissertations

N in each category	NADE	RiDE	RTDE	JDE	DISSERT
1. Developmental programs	83.5%	85.0%	97.6%	76.4%	100%
a. Persons/participants	8.3%	8.0%	10.6%	2.1%	27.3%
i. Students	5.2%	4.0%	10.6%	1.7%	18.2%
ii. Faculty	2.0%	4.0%	~	0.2%	6.1%
iii. Other personnel	1.0%	~	~	0.2%	~
iv. Mixed content	~	~	~	~	3.0%
b. Administration & supervision	15.5%	29.0%	27.1%	13.5%	48.5%
i. Goals and outcomes	3.1%	7.0%	4.7%	1.7%	6.1%
ii. Policies and processes	9.3%	13.0%	17.6%	8.1%	21.2%
iii. Governmental and system topics	1.0%	1.0%	1.2%	0.8%	3.0%
iv. By funding type	~	1.0%	~	~	~
v. International	1.0%	~	~	0.4%	~
vi. Mixed content/survey	1.0%	7.0%	3.5%	2.5%	18.2%
c. Educational theory and practice	48.5%	44.0%	56.5%	55.3%	15.1%
i. Theoretical systems/theories of action	9.3%	8.0%	4.7%	6.6%	~
ii. Instructional design/models	6.2%	2.0%	3.5%	4.4%	~
iii. Computer Based Instr./technology	~	2.0%	1.2%	2.9%	~
iv. Collaborative learning	2.0%	2.0%	~	1.0%	3.0%
v. Instructional assessment	~	5.0%	1.2%	0.6%	~
vi. Content area theories of action/applications	22.7%	21.0%	40.0%	32.9%	9.1%
a. Reading	5.2%	6.0%	9.4%	5.2%	~
b. Writing/English	8.2%	4.0%	12.9%	7.1%	~
c. Mathematics	3.1%	8.0%	10.6%	5.8%	9.1%
d. Study skills	3.1%	~	2.4%	1.2%	~
e. Reasoning/Critical thinking	~	~	2.4%	11.0%	~
f. ESL	1.0%	~	2.4%	1.0%	~
g. Other/general	2.0%	~	~	0.4%	~
h. Multiple content areas	~	3.0%	~	1.2%	~
vii. Support programming	5.2%	3.0%	5.9%	5.4%	3.0%
a. Tutoring	1.0%	3.0%	~	2.3%	~
b. Supplemental instruction	1.0%	~	4.7%	1.7%	~
c. Learning Assistance Centers	~	~	~	1.0%	3.0%
d. Advising	1.0%	~	1.2%	~	~
e. Student services programming	1.0%	~	~	~	~
f. Mixed content	1.0%	~	~	0.4%	~
viii. Mixed content	3.1%	1.0%	~	1.5%	~
d. Equity, access and balance issues	7.2%	4.0%	3.5%	5.1%	~
i. Multicultural/diversity	2.0%	1.0%	~	0.6%	~
ii. Gender	~	~	~	0.2%	~
iii. Ethnic groups	~	~	1.2%	1.2%	~
iv. Age	1.0%	~	~	~	~
v. Disability	1.0%	1.0%	~	1.7%	~
vi. Affective/non-cognitive topics	1.0%	2.0%	1.2%	0.6%	~
vii. Mixed	2.0%	~	1.2%	0.8%	~
e. Mixed content	4.1%	~	~	0.4%	9.1%
2. Perspectives	13.4%	3.0%	2.4%	6.7%	~
a. Historical or predictive	5.2%	3.0%	2.4%	4.0%	~
b. Philosophical/theories of practice	6.2%	~	~	2.5%	~
c. Mixed content	2.0%	~	~	0.2%	~
3. Resources	2.0%	12.0%	~	16.3%	~
a. Personal prof. devel.	~	~	~	0.8%	~
b. The literature	~	4.0%	~	5.4%	~
i. How to approach	~	1.0%	~	~	~
ii. Meta-analysis	~	~	~	0.6%	~
iii. Bibliographic and reference	~	3.0%	~	4.8%	~
b. Technology	~	~	~	8.7%	~
c. Professional organizations	~	~	~	0.4%	~
d. Research/research agenda	2.0%	8.0%	~	1.0%	~
e. Mixed content	~	~	~	~	~
4. Mixed content	1.0%	~	~	0.2%	~

As noted above, every effort was made to use terms and phrases which are self explanatory as category titles. For example, two of the four category headings in the primary topic area “Developmental programs” are easily understood especially when the subcategories are considered. “Persons and participants” includes students, faculty, and other personnel. “Administration and supervision” includes content pertinent to the oversight of developmental programs. Specifically, this category includes content regarding goals and outcomes (real and desired) of developmental programming, the policies and processes in developmental programs, governmental and community college system specific topics, developmental programs based on funding sources (i.e. Title III, Title V, etc.), and administrative and supervisory information from programming outside the United States. However, several of the category and subcategory names require explanation for the proposed architecture to be used effectively. The category “Educational theory and practice” includes several subcategories which require description and the category “Equity, access, and balance issues” requires further explanation.

“Educational theory and practice” is easily understandable as a category heading. However, two of its subcategories require description. “Theoretical systems/theories of action” is the first of these. Content in this subcategory focuses on facilitation of general application of educational theory. A theory of action “is a theory that gives rise to some judgment, given the nature of truth that the theory describes, as to how theoretical knowledge can be applied in dealing with practical problems” (Owens, 2004, p. 66). Examples of articles in this subcategory are Friedman’s article in the 1997 NADE monograph regarding adult learning theory, “Comprehension Monitoring: The Neglected

Learning Strategy” by Weinstein and Rogers in Volume 9, Issue 1 of the JDE (1985) and “Special Feature: A New Paradigm for Teaching with Technology” by Koehler in the fall 1998 issue of the same journal. “Instructional design/models,” the second subcategory which requires explanation, is distinguished from “Theoretical systems/theories of action” by the level of specificity. In these articles an instructional pattern, with explicit reference to a theoretical system upon which it is based or without this, is provided as a blueprint or recipe for a “desired outcome” (Gunter, Estes & Schwab, 1999, p. 59). Examples of articles in this subcategory are “Focus on Communication through Folk Tales and Story Telling” by Behrens, Neeman and Newman (2002), “Techtalk: Teaching Writing Online” by Caverly and MacDonald (2000) and “Techtalk: Expanding the Online Discussion” by MacDonald and Caverly (2001). Both subcategories, “Theoretical systems/theories of action” and “Instructional design/models,” have the potential to spawn additional specific topic areas for inclusion in the architecture. As more theoretical systems are described and applied in the literature of developmental education, a critical mass of publications will be reached and a specific subcategory or topic area like “Collaborative learning” will grow out of the “Theoretical systems/theories of action” and “Instructional design/models” subcategories.

The category title “Equity, access, and balance issues” was devised from terms commonly used in the literature of developmental education and Education in general. It is intended to summarize the literature discussing challenges and opportunities presented by multicultural settings and diversity, by gender related constructs, considerations of the characteristics of specific ethnic groups, information related to the impact of the age of participants, material regarding disabilities and their impact on developmental education

and its settings, and affective or non-cognitive emphases in the literature. In each of these areas, equity in opportunity, access to and successful passage through, and a balanced or holistic approach to the individual and to all services of developmental education for the populations listed is the primary emphasis. Examples of content in this category include Bruch's "Towards a New Conversation: Multiculturalism for Developmental Educators" (2001), Jenkins' "Factors which Influence the Success or Failure of American Indian/Native American College Students" (1999), and Yanok and Broderick's 1989 publication "Program Models for Serving Learning Disabled College Students."

Readers familiar with the literature of developmental education will have noted that the two articles from the JDE feature "Techtalk" listed above were not classified under "Resources for developmental education: Technology." Each of the articles listed above communicated a blueprint for pursuing a specific "desired outcome" (Gunter, Estes & Schwab, 1999, p. 59) in instruction. As a result, they were classified as "Developmental Education Programs: Educational theory and practice: Instructional design/models." While the majority of the "Techtalk" feature was classified as either "Resources for developmental education: Technology" or "Developmental Education Programs: Educational theory and practice: Computer based instruction/technology," a combination that equals over 11% of the content of the JDE across 24 years, there were instances in which the subject matter and purpose of the feature's content dictated classification in a different category and subcategory. This circumstance is not limited to the feature "Techtalk." For example Akst and Hirsch's 1991 "Selected Studies on Math Placement" might appear to be a mathematics specific article until one understands that its focus is placement of students in developmental mathematics, a program

administration concern. It was classified as “Developmental Education Programs: Administration and supervision: Policies and processes” as the content would inform the process of planning and monitoring student placement in developmental mathematics, an administrative or supervisory function. The reader should note that the proposed architecture is not an annotated bibliography. These are available from the National Center for Developmental Education. It is an attempt to represent the range of topics addressed in the literature of developmental education, the relationships between these topics and to gauge the volume of and sources for information in each topic area. This occasionally involved categorizations of articles which would appear inaccurate based solely on the title of the article.

This proposed architecture of the literature can be considered representative. It is based on nearly 800 items published across a 24 year period. This group includes nearly every item published in four of the major source publications in developmental education and dissertations in the field. As the proposed architecture can said to be representative, the following can be said about the literature of developmental education (these observations are not intended to be exhaustive).

The literature of developmental education has three primary topics. These are “Developmental Programs,” “Perspectives of Developmental Education,” and “Resources for Developmental Education.” Occasionally authors draft literature which includes emphasis in two or even three of these areas. To account for this, the proposed architecture of the literature has a fourth primary heading, “Mixed Content.” In each of the publications that have been incorporated into the architecture, consideration of developmental programs is the bulk of the literature (Table 1). There is little content in

the literature that straddles two or three of the major divisions (Table 1) which, as noted above, can be seen as evidence that these divisions are accurate representations of exclusive primary emphases in the literature.

The topic area in developmental education receiving the most consideration by authors is “Developmental Programs.” Presently, this topic area includes content related to the “Persons or participants in developmental education,” “Administration and supervision of developmental education,” “Educational theory and practice,” and “Equity, access and balance issues.” The most commonly addressed category in this group is “Educational theory and practice” comprising between 44% and 56% of the articles published by NADE and in RiDE, RTDE and the JDE. Understandably, this category includes a much smaller percentage of the dissertations considered.

The subcategory receiving the most attention in the literature of developmental education is “Content area theories of action/applications” (i.e. Reading, English, Mathematics, Reasoning/Critical Thinking). Between 21% and 40% of all the articles published in the periodicals used to develop the proposed architecture focus on a content area specific application. Of the publications considered, RTDE has focused most heavily on this subcategory. The focus on content area specific considerations is, in the opinion of this author, a product of the nature of the field. The vast majority of persons active in the field are practitioners who specialize in providing instruction within a given content area. That the focus of these persons is predominantly “Educational theory and practice” especially as it relates to the academic discipline in which they teach should be expected.

One primary topic area and several subcategories have received very little consideration in the literature of developmental education. The primary heading

“Resources for Developmental Education” includes five subcategories in which content was found in only one of the periodicals. With the exception of “Technology” which has been addressed in a regular feature in the JDE for the last 24 years, these subcategories contain 1% or less of the published material for the periodical. These areas are “Personal professional development,” “How to approach the literature,” “Meta-analysis of the literature,” and “Professional organizations.” Each is an important topic for developmental educators. The very limited content in these areas indicates an area of opportunity for authors and a possible area of need for practitioners. Outside this topic area, there are other subcategories with very limited content. These are “Other personnel” in the category “Persons/participants,” “By funding type” and “International” in the category “Administration and supervision,” and “Gender” in “Equity, access and balance issues.” This author suggests that knowledge of the characteristics of successful program directors or successful academic assistance advisors, “Other personnel,” would be valuable to community college administrators and supervisors of developmental programming. He also suggests that knowledge of sources of funding, the particulars of acquiring and administering these funds, and an understanding of developmental education activities outside the United States would be valuable. Finally, a better understanding of gender distinctions and their impact on developmental education is in order. While many investigations have included this characteristic, a continuing discussion focused on the research results and their implications has not yet developed in the literature. The portions of the literature receiving less attention may be a result of the relative youth of the publications, a perception among parties active in the field that these topics are not pressing concerns, or a number of other circumstances. While the proposed

architecture can not address the causes for activity in the literature in one area as opposed to another, it can and does highlight the relative weighting of topic areas in the literature of developmental education.

The significant weighting of the literature toward “Educational theory and practice” across the major publications considered and the areas in the literature which have garnered little interest illustrate another characteristic of the field of developmental education. It has to date had an internal as opposed to external focus. As an area of practice in higher education which has relatively recently developed organizing structures and which has faced resistance, this is to be expected. However, it can be limiting. The problems faced by American educators in respect to underprepared college students are not unique. Much could be learned from educators who work with these populations in other countries like Australia (Green, Hammer & Stephens, 2005; Milnes, 2005; O’Regan, 2005). In addition, the challenges and opportunities faced by developmental educators are, for the most part, not unique to developmental education. Many academic disciplines have developed theorems and content that is directly applicable to the field of developmental education. A primarily internal focus inhibits the ability of developmental educators to model the type of thought and practice many champion for students, integrating theory and practice across multiple academic disciplines.

The proposed architecture also provides a perspective of the publications included in its development. Two of the periodicals are comprehensive. In the 24 years of content considered, the JDE has addressed nearly every topic present in the literature of developmental education. It is the most comprehensive source cataloged in the proposed architecture. The NADE monographs and digests are the next most comprehensive source

and they share a significant emphasis on historical and philosophical perspectives of developmental education with the JDE. The average developmental educator could establish a broad perspective of the field reading either but has immediate access to all the content of the second on the NADE website. However, these monographs and digests include 97 articles as opposed to the 481 in the JDE content cataloged. Of the two, the JDE has the greatest depth and breadth of the material available. JDE content is available through subscription databases and in the periodical collections of many university libraries.

Two of the periodicals used to construct the proposed architecture are not comprehensive in their consideration of developmental education. 81% of the content of RiDE was classified in three categories of the primary heading “Developmental Education programs.” These three categories are “Persons/participants,” “Administration and supervision,” and “Educational theory and practice.” RiDE has intentionally or as a result of the interests of the authors submitting manuscripts specialized in these areas. When the attention given to resources regarding research is included, 90% of the content of RiDE is accounted for. 94.2% of the content of RTDE was also classified in the first three categories of “Developmental education programs.” Based upon the proposed architecture, one can say this publication has had the most narrow focus of the four publications cataloged with 83.6% of its content in the “Administration and supervision” and “Educational theory and practice” categories. The only topic which was covered in the “Persons/participants” category by RTDE was “Students.” However, these characteristics should not be interpreted as short comings.

For developmental educators seeking a concentrated exposure to research focused on developmental programming and many of the traditional concerns of developmental education, RiDE is a good choice. RiDE content can be said to be traditional as the “Educational theory and practice: Content areas” subcategory it is almost exclusively focused on Reading, Writing/English and Mathematics (the only exceptions are the three “Multiple content areas” articles two of which include critical thinking, the third includes study skills) and there is very limited content in the “Equity, access, and balance issues” category and in the “Support programming” subcategory. 94.2% of the content of RTDE was also classified in the first three categories of “Developmental education programs.” RTDE has 12% more of its content in “Educational theory and practice” than RiDE, showing strong emphasis on this category. RTDE included manuscripts addressing more of the content areas of developmental education than RiDE and gave twice as much attention to “Support programming” as RiDE however, it had slightly less content in the “Equity, access and balance issues” and “Perspectives of developmental education” topic areas and no content under the “Resources for developmental education” heading. This information has utility for the average practitioner in developmental education as it allows for selective use of the major publications based upon the user’s purposes.

As noted above, the proposed architecture was the work of one person and may reflect bias, was based upon a sampling of the literature and portrays structures and relationships which may have changed. In addition, the proposed architecture is not the only way to describe the literature. It does not weigh the merits of the articles classified nor does it divulge the type of literature, report of research or scholarly opinion. Its utility

will be found in consideration, use and critique by persons other than the author. To that end, the author offers the following list of applications and implications.

Applications/implications

The most apparent application for the proposed architecture of the literature of developmental education is in the comparison of the periodicals used to construct it. Readers may use the architecture to identify areas of emphasis and topics omitted in the publications. Given a particular purpose, they may also use the architecture to form a general perspective of which of the periodicals will best serve their purposes. Researchers can extend these applications to include use of the architecture in descriptions of the literature, the identification of areas of historic interest, the identification of topic areas in which little research exists, and the planning of reviews of the literature.

A second area of application for the proposed architecture is as an organizational scheme. The primary topic headings and their categories and subcategories can function as an outline of the topics of interest and concern in developmental education. This could aid developmental educators as they continue to form and share perspectives and converse about the persons, administration, theory, issues and resources in their area of practice. It provides an organizational pattern for what has been predominantly a free form conversation. Perhaps more significantly, it could aid developmental educators as they discuss the same constructs with faculty peers, administrators, members of the public and politicians. The proposed architecture provides a fairly simple rubric by which one's thoughts and the information to be shared with persons outside the field can be organized. For example, it can provide required structure for meetings with public officials and community college system personnel. The ability to direct these

conversations based upon a common desire to understand programs, perspectives and resources and the ability to discuss programming in terms of persons, administration, educational theory and practice, support programming and equity, access and balance issues would greatly facilitate interaction and understanding. The structure of the literature and developmental education the proposed architecture reveals, the combined wisdom of many persons active in developmental education, can provide needed structure for the conversations among developmental educators and between developmental educators and persons outside the field.

The architecture itself could be expanded. The material cataloged could be summarized in a topical index or bibliography of the literature of developmental education. Such a product would increase opportunities for authors and researchers by providing a reference which would facilitate reviews of the published works of notable figures, considerations of the historical developmental of concepts and emphases in the discipline, greater ease in preparing reviews of the literature and meta-analytical publications and identification of persons who have developed areas of specialization.

The proposed architecture of the literature was developed using four of the primary publications in developmental education. It was developed in an inductive manner seeking to reveal the existing structure of the literature. It identifies the three primary topic areas of the literature of developmental education and the related categories, subcategories and topics. As such, it has utility for all persons interacting with the literature of or with the field of developmental education.